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Fitting Machines to Small Farms

FARM operating equipment is being scaled down to meet the needs and pocketbooks of the more numerous small farmers. This involves difficult engineering from the standpoint of equipment production, as substantially the same number of parts must be machined as for a large equipment unit, and to as close or closer tolerances, at a lower cost, if possible. It does not accomplish the theoretrical ideal of building into one unit as much capacity as the operator can control, or of reducing to a minimum the production cost per unit of production. It does represent engineering to meet the reality of present needs and capital limitations of large numbers of farmers. It fits the machine and machine investment more closely to their present scale of operations, enabling them to take definite steps forward in low-cost production.

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VOL 19, NO 11 EDITORIALS NOVEMBER 1938

The Agricultural Engineering Scene

PARTICULARLY live subjects in agricultural engineering at this time are indicated by the program for the fall meeting of the A.S.A.E., which was built from the suggestions of a large number of members as to their immediate interests, developments in progress, and authoritative speakers.

Forage crops command attention as a balky horse delaying progress in farm production efficiency. Corn, grasses, and legumes are definitely in the competition for high yield, low-cost handling, high feed value, soil conservation, and other considerations of low overall cost of production.

Pneumatic tires for farm traction and transport have won their battle against skepticism and are being engineered in detail for adaptation to this particular class of service.

Farm tractor fuels represent a technical problem in power cost and trouble-free operation complicated by taxes, regulations, and supply situations.

Market situations and governmental encouragement of crop storage have placed a premium on farm storage technology.

Ventilation has graduated into a rapidly growing technology of air conditioning applicable not only to public buildings and industrial processes, but to farm living and working conditions, specialized crop production, most branches of livestock production, animal and plant disease control, farm crop drying and curing, and various problems of storage, sanitation, preservation, shipment, and marketing.

Silos, separate hay storage, and one-story barns are still a new, developing combination in planning for farm operating efficiency.

Rural electrification holds interest as a continuing extension problem. Farm applications of electricity suggested by common urban uses are being supplemented by the development of distinctly agricultural applications of electrical effects. Farm acceptance provides incentive for further development.

Recognition of the tieup between conservation, flood control, and farm practices provides moral and financial support for continued development in the hydraulics and related engineering of water as it occurs on farms. Differentiation of the behavior, effects, and use of water on farms from its phenomena in larger bodies and for other uses, together with the relatively small amount of existing data and urgent demand for immediate control have put a pressure on research and development in this field.

These are present indications of major opportunities for progress and service through agricultural engineering technology. In the fall meeting of the A.S.A.E. agricultural engineers will advance their technology in these and other directions by personal contacts and exchange of information and viewpoints. The program provides a setting; those attending will provide the exchange of the mental wherewithal of progress.

Chemurgic Research Laboratories

FOUR regional laboratories for chemurgic research are being set up by the U. S. Department of Agriculture. The extent to which agricultural engineering research may be included in their programs is indicated by the recent reorganization of the U.S.D.A., in which the Bureau of Agricultural Engineering is to work in close cooperation with the Bureau of Chemistry and Soils, as one integrated unit, "with the purpose of speeding up the federal government's attack on the problems of finding new and expanded uses for farm products and improving the machine processes in producing and refining them." In this situation it seems desirable to again invite consideration of the part agricultural engineering can play in chemurgic progress.

Technical possibilities of biologic production in the United States are limited only by the world of plant and animal life forms, environmental conditions, and man's ability to modify either or both of the factors of inheritance and environment.

Technical possibilities of finding new nonfood uses for biological products begin with thousands of combinations of organic compounds and of physical and chemical properties. These are multiplied by their susceptibility to chemical and physical change by man to meet existing or potential wants for consumer goods, either directly in the form of such goods, or indirectly in the improvement of capital goods.

Practical possibilities in this field include those combinations of technical possibilities which can be applied economically in farm and factory operation to produce a marketable product at a satisfactory cost. Appropriately, with a view to early practical results, the research of the regional laboratories will begin with the common farm crops of their respective areas, crops which have proven so adaptable to large areas of this country that yields have outgrown use at common production costs. At some future time these laboratories may logically be authorized to extend their research over a wider range of present and possible new crops and animal industries.

In the pure science of developing biologic potentialities and knowledge thereof, modification, measurement, and control of environmental conditions to accurately defined specifications is partly a function for agricultural engineers. It involves work for which they are qualified. Heredity and environment, as related phases of biologic science, may be expected to enjoy a closely parallel and interdependent progress. On the environmental side agricultural engineering research can contribute materially.

As to new nonfood uses for biologic products, agricultural engineers are particularly close to the capital goods requirements of agriculture—the structures, equipment, and supplies which increase farm operating efficiency, and the combinations of properties required in these goods. Thus they are in a position to quickly recognize and to test the possible utility of any new product which may provide desirable combinations of weight, strength, fire resistance, machinability, dielectric strength, thermal and sound insu-

lation, transparency, chemical stability, and other properties for specific uses in farm structures, equipment, and operations. They also know something of the properties of materials required in other industries and in various consumer goods. This spells definite usefulness for agricultural engineers in the chemurgic laboratories both in detecting possible uses for new products, and in tracing specific needs back to farm source materials with which those needs might be satisfied.

In reducing technical possibilities to economic practice, agricultural engineering technology is necessarily a key factor. It holds the answer to practical possibilities in farm control of the environments of biologic production; to many considerations in the extension of farm production service by farm processing operations. It holds the answer to farm limitations in meeting factory requirements for raw material delivery time, condition, and cost. It can determine and increase the extent to which the farmer can become his own customer, in the capital goods that he buys to continue his operations.

These may not include all the opportunities for agricultural engineering usefulness which may develop in the chemurgic research program, but they indicate to some degree the potentialities of the present U.S.D.A. plan for close cooperation between chemists and agricultural engineers in its regional chemurgic laboratories.

Engineers on Invention

A FURTHER contribution of the American Engineering Council to public understanding of economic and social developments influenced by the work of engineers is its second public forum being held in Detroit, November 11.

"Invention and the Engineers' Relation to It" is the general subject on which a wide range of leading engineering and business viewpoints and fact sources will be concentrated in this particular gathering.

In the confused economics of this decade various well-meaning citizens and legislators have attacked technological progress and an important source of its lifeblood, patent protection for inventors. Additional attacks are in prospect. It is not enough to dismiss the arguments against technological progress and patent profit as spurious. Engineers would be guilty of neglecting their ultimate clientele, the general public, if they left it in a situation of having to base its opinions and actions on only the one side of the argument which is insistently presented.

A neat summary of one public advantage of technological progress, as aided by our patent system, is included in the booklet "Industrial Price Policies," published by the Public Affairs Committee. Referring to the difficulty of achieving and maintaining a monopoly, the study represented reports as follows: "This shows that there is a trend away from monopoly and that this trend is due in large measure to technical developments. In the present-day world, attempts to boost prices and keep them at an unfair level are in danger of defeating themselves. Applied science is likely to find other means of progress. The man who tries to fence in an industrial highway and exact an unfair toll from all wayfaring consumers courts disaster. The chemist will build a detour around him, the physicist will dig a tunnel under him, or a biological overpass will be constructed. He may think he has throttled competition, but it will spring up again from new directions. Business is beginning to learn and respect this basic law."

To this might be added the obvious inference that the limited monopoly created by a granted patent is continually subject to practical destruction by newer inventions. A patent, in effect, is only a 17-year lease to property created by the inventor. It protects the property, in a measure, from theft, but in no way prevents other inventors from creating competitive property. In fact, it encourages this competition.

Invention is a highly competitive means of earning a living, with the result that individual and corporate earnings from this activity are no more than reasonable for the ability, training, work, and risk represented. Any legislation to decrease the returns from patents might be expected, from the standpoint of inventors, to crowd out the lower margin of this field into other already crowded fields of endeavor. A more significant result to be expected would be a decrease in technological progress and in new employment opportunities, decreased constructive competition for those inventors who were able to continue in this field, and increased destructive effort in the form of abuses.

As a philosophical precept, we submit that a system which is intrinsically evil in design and personnel may best be policed from the outside, but a system which is intrinsically good in design and personnel can best be improved from within, by those who best understand the details of its operation.

Like all man-made and man-operated agencies, patent systems here and elsewhere leave room for improvement. If the American public is given the correct information on its patent system, we believe it will decide that the system is intrinsically good, and will gladly support continued improvement from within, while protecting it from tampering by uninformed reformers. The A.E.C. public forum on the subject should do much to call public attention to facts about public benefits from invention encouraged by patent protection, to bring together a consensus of informed opinion on the subject as a reference and guide to public policy, and to stimulate progressive development of the patent system for the greatest public good.

Safe Farm Equipment

HANDS, arms, legs, and lives have always been, and probably always will be, a part of the human cost of farm operation. The National Safety Council and farm equipment manufacturers are, however, taking active steps to reduce that cost to a minimum, so far as accidents with farm equipment are concerned.

The total physical hazards of farming have probably decreased, but new equipment has brought new dangers. Investigation has strongly indicated that most accidents with equipment are preventable. We have a private theory that the fellow who risks his hand to save a few minutes in operating a corn shredder is the reincarnation of some ancestor who had a tame bull, or who hurried back to see why his last shot of dynamite failed to explode.

Farm equipment can no more be made foolproof than a farmer can be made to keep his hands in his pockets. But safety can be made the farmer's own responsibility with warnings plainly stenciled near the dangerous parts of every farm machine, and by otherwise frequently advising him of the specific known hazards of his occupation. It is gratifying to see that this is being done, and that agricultural engineers are cooperating in this activity.

Grass Silage

By Frank H. Hamlin

ENSILING GREEN RYE. ENOUGH MOLASSES TO PRESERVE EACH LOAD IS POURED INTO THE MEASURING TANK FROM WHICH IT RUNS INTO THE LOWER PART OF THE BLOWER. A VALVE CONNECTED TO THE UPPER FEED ROLL OF THE CHOPPER REGULATES THE FLOW OF MOLASSES ACCORDING TO THE AMOUNT OF RYE GOING THROUGH THE CHOPPER

MORE PEOPLE and more capital are employed in agriculture in the United States than in any other enterprise (1)[1]. The production of livestock and livestock products is the country's largest industry (2). Pasture, corn, and hay, the three principal raw materials of the livestock industry, are far more important, in terms of both acreage and value, than wheat, cotton, oats, barley, tobacco, and potatoes combined (3). The growing, harvesting, storing, and feeding of a large part of these three all-important crops is on the point of being radically changed by the development of methods by which grasses, legumes, and immature cereals can be preserved as silage.

In 1936 "grass silage" was a virtually meaningless term on farms of the United States. In 1937 several thousand farmers made and fed it with astonishingly universal success. There is good reason to believe that over one-half million farmers can and will adopt grass silage in the course of the next few years. The rate of adoption depends almost entirely on the rate at which practical information on grass silage is given to livestock farmers throughout the country.

Upwards of 40 million tons of silage, largely made from corn and the sorghums, are fed in the United States annually. Some 80 million tons of hay are fed. When corn or the sorghums are properly ensiled, they can be fed with less than a 10 per cent loss in the original nutrients of the growing crop. Under favorable conditions, the loss may be held below 5 per cent. When hay crops are handled in the conventional way, at least 20 per cent of the original nutrients are lost during field curing, harvesting, storage, and feeding — even under favorable conditions. Losses probably approach 30 per cent on the average, and may, under unfavorable weather conditions, run from 40 per cent to total loss (4). In many areas, enormous supplies of feed are lost each year through lack of a means of preserving surplus pasture growth during the lush period for use during the following dry period.

Such serious losses in converting growing crops into feed for livestock could be reduced to the 5 per cent to 10 per cent range of corn silage, if they could be ensiled with equal success. Unfortunately, these crops do not, by themselves, make uniformly good silage (5). The addition of relatively small amounts of blackstrap molasses to the green material as ensiled, however, preserves the silage with as little loss in original nutrients as occurs in corn silage. Where available at reasonable cost, other preservatives (notably commercial phosphoric acid) are being used with equal success.

The nutrients of the molasses used to preserve the silage are still at least 75 per cent available, partially in the form of lactic and other organic acids (6). Research work in Austria indicates that lactic acid has a favorable influence on the retention by animals of the calcium, phosphorus, and nitrogen in their rations (7). The use of more molasses than is required for the preservation of the silage simply adds nutrients, often at relatively low cost. The excess molasses is retained 98 per cent in its original form (8).

Phosphoric acid also pays its own way to a considerable extent by correcting phosphorus deficiencies in the livestock rations of many areas and by adding phosphorus to the soil via the manure route. At the current price of phosphoric acid in New York state, phosphorus can be put on the land in this way at only slightly more cost than by the direct application of superphosphates (9). There is some possibility that phosphorus may eventually be made available in the form of acid at no more cost than in the form of superphosphates.

Grass silage can be made in many of the important livestock producing areas at less cost per ton than corn silage (10). With proper equipment and management, hay crops can be harvested, stored, and fed as silage at less over-all cost per acre than as field-cured hay (11). Protein can be produced at less cost in grass silage, made from early-cut hay crops, than it can be grown or purchased in any other readily available form (12).

Grass silage is being profitably used in the rations of all classes of livestock, including dairy and beef cattle, sheep, swine, and poultry. It may be used to replace all or part of the dry hay in the ration, all or part of the corn or sorghum silage in the ration, to supplement pasture during the dry period, to replace part of the grain or high-protein concentrates in cattle rations (13).

The federal farm program involves three major objectives: (1) Soil conservation and building, (2) reduction of agricultural surpluses, and (3) the ever-normal granary.

The most practical, least expensive, and most widely-followed soil conservation practice calls for the replacement of soil-depleting crops by soil-conserving crops—especially

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Presented before the North Atlantic Section of the American Society of Agricultural Engineers, at Boston, Mass., September 21, 1938.

Author: Research engineer, Papec Machine Co. Mem. A.S.A.E.

[1]Numerals in parenthesis refer to references listed at the end of this paper.

the nitrogen-fixing legumes. Corn, the sorghums, and small grains are soil-depleting crops. Molasses silage or phosphate silage, made from soil-conserving hay crops, can be used to replace corn and sorghum silage and also part of the small grains normally used in the ration. Farmers whose corn acreage allotments are insufficient to take care of their normal grain and silage requirements, can solve their problem with grass silage. When soil-conserving crops are harvested as additional hay, they are of little value in replacing soil-depleting crops as far as the economy of the feeding program of most farms is concerned.

Supplies of blackstrap molasses from all sources greatly exceed normal consumption. As a result, our southern producing states, notably Louisiana, have great difficulty in moving their annual production at profitable prices. In the drought year of 1936, agricultural consumption of blackstrap was increased 25 per cent almost entirely as a result of a short, inexpensive but tremendously effective effort on the part of the U. S. Department of Agriculture and cooperating extension forces to promote the feeding of molasses to supplement a short corn crop. The grass silage development offers a larger and more permanent market in agriculture for this surplus agricultural crop. Available supplies of Cuban and Hawaiian molasses apparently insure against any material advance in the price of blackstrap to the farmer for many years to come.

Phosphates are recognized as one of the least developed of our great natural resources. The use of superphosphates in growing soil-building legumes is encouraged by AAA payments. Applying phosphorus by the phosphate silage-manure route is already economically practical in the Northeast and is equally subject to encouragement under the AAA program.

The theory of the ever-normal granary has thus far been developed around grain crops only. The country's hay crop, however, is vastly more important in the livestock picture than all grain crops put together (3). Because of its bulk the storage of dry hay, whether baled or loose, over long periods of time is impractical and expensive. Furthermore, dry hay deteriorates in feeding value during storage (14). Silage can be carried over long periods with practically no loss in feeding value. Moreover, a hay crop in the form of silage requires less than one-third the storage space required for whole dry hay and 40 per cent less space than required for baled hay, as indicated by the following table:

	Whole hay	Baled hay	Grass silage
Feed stored per cubic foot, lb	5	10	45
Dry matter stored per cubic foot, lb	4	8	14
Cubic feet per ton of feed	400	200	44
Cubic feet per ton of dry matter	500	250	147

A silo is the least expensive type of permanent storage structure that can be built on the farm, but, being virtually airtight, is impractical for the storage of field-cured hay crops from which the heat and moisture of "sweating" must be dissipated for best keeping qualities (15). The construction of silos may be financed under the Federal Housing Act. An 18-ton temporary silo can be had for as little as $20 plus cost of farm labor for erecting. A trench silo may be had for the cost of digging it.

One hundred and fifty million dollars worth of farm property is destroyed by fire in the United States each year. Twenty per cent of this loss is accounted for by spontaneous combustion in stored hay (16). Nine times out of ten, barn fires from other causes either start or get out of control in the hay mow. Grass silage, being 70 per cent water, will not burn spontaneously or otherwise.

MOWING, WINDROWING, AND LOADING GRASS FOR GRASS SILAGE—ALL IN ONE OPERATION, WITH ONE MAN DOING ALL THE WORK—ON THE SUNNYGABLES FARM OF H. E. BABCOCK IN NEW YORK

Large savings in barn construction costs can be made by planning to store hay crops as silage. Silos will provide the necessary storage space at less cost per cubic foot than a conventional hay mow, and each cubic foot stores over three times as much feed. One-story stables with silos for roughage storage can be and are being built for 25 to 35 per cent less money than conventional two-story barns designed to take care of the same amount of stock. The separation of roughage storage from the stable not only materially decreases fire hazards, but also opens up a broad, new market for such fire-resistant materials as steel sheets, concrete, and tile.

Grass silage is now being made in every part of the country. To date it has been most widely adopted as a regular farm practice in Wisconsin, Ohio, and the Atlantic seaboard states from Maine to Florida, largely because it was first introduced in these areas. There is good reason to believe, however, that grass silage is fully as well adapted to the needs of other areas. In the South, huge tonnages of forage crops can be grown per acre, but cannot generally be made into hay without serious losses. In the corn belt, as in most other areas, first-cutting alfalfa crops are frequently lost due to inclement weather. Erosion is a serious problem in nearly all areas (17).

While grass silage may never seriously compete with corn and the sorghums for beef cattle feeding in the central and southwestern states, it promises to be an important competitor of field-cured hay wherever hay is made for home feeding. In recent steer-feeding trials, alfalfa molasses silage produced much faster and more profitable gains, when fed with ground ear corn, than did either corn silage with protein supplement or alfalfa hay (18). It should also be noted that, under modern grassland management, as much as 18 to 20 tons of green alfalfa and clovers are being grown to the acre, thereby producing up to 4500 lb of total digestible nutrients and 1600 lb of protein per acre. Timothy, wheat, and vetch, and pasture grasses have been made to yield better than twelve green tons per acre at relatively low cost. Production of this kind is being obtained in New Jersey and the Province of Ontario at less over-all cost than for producing equivalent yields with corn (19). A New York operator grew 8 tons of soybean silage to the acre on turned-under timothy sod which had already yielded 7 tons of silage per acre earlier in *(Continued on page 478)*

Marketing a Prefabricated Septic Tank

By Max E. Cook

IN THE farm structures field the demand is for structures that will lower farm production costs. This demand is best met by structures of lower unit costs and improved types that effect economies in farm management, but the best recommendations from the most reliable sources are of little value if the farmer is not induced to follow them. To make a recommendation is one thing; to secure adoption is quite another. This is a major problem with those of us who are working toward the improvement of farm structures.

One of our strongest allies is the retail lumber dealer, who holds a key position when it comes to influencing the farmer in the solution of his building problems. My experience has taught me that most good farmers appear, figuratively speaking, to "come from Missouri." They much prefer to be *shown*, rather than *told*, how to improve a given structure.

One of the most effective ways of submitting a structures recommendation, not only to the farmer, but to his dealer and to all others interested, is by means of scale miniatures or models, and in the case of smaller structures, actual replicas.

I am not advocating prefabrication for farm dwellings and farm structures other than the smaller utility structures and accessories. However, standardized prefabricated units have definite advantages, including definite control of the grade of materials most suitable to insure satisfactory service and long life.

Let us take as an example a septic tank for the farmhouse or isolated dwelling. A review of the septic tank recommendations and requirement of some 35 state boards of health and state universities, and of as many more ordinances of various types, selected at random, leaves one puzzled, to say the least. Hardly any two are in accord. Minimum working capacity ranges all the way from 405 gal (Missouri College of Agriculture) to 1100 gal (Minnesota Department of Health). The average minimum working capacity is 563 gal.

A recent review by the U. S. Public Health Service of the recommendations relative to septic tanks covering the states east of the Mississippi River disclosed an average minimum recommendation of 500 gal.

Septic tank capacity recommendations for households of 6 to 7 persons, by 28 widely known manufacturers of septic tanks and mail-order houses, the majority with national distribution, range from 160 gal to a single high of 360 gal, with an average of but 185 gal, which is in reality little more than a wide place in the sewer.

Where is a farmer, or the owner of an isolated house, to turn for proper guidance? He may get off to a good start with a good bulletin on the subject secured from his farm advisor or the extension service, but unfortunately the country seems to be overrun with septic tank and sewage disposal "experts," and after they are through advising and making improvements it is doubtful whether the university would ever recognize its "child."

Prefabrication, at least as practiced at present, may not be the answer, for it would appear that the great majority of the tanks on the market are made to sell and not to serve. On the other hand, a tank manufactured in sectional interchangeable units, to permit of assembly in any required capacity, goes a long way in the right direction.

The value of miniatures or models to assist in visualizing a structure, whether it be a septic tank, feed hopper, irrigation gate, or building proper, can hardly be overrated. I strongly urge extension workers to make a maximum use of miniatures or models and, wherever and whenever feasible, to arrange for full-size displays of farm structures and accessories.

Typifying the value of miniatures or models, as well as prefabrication following accepted design, are the redwood sectional septic tank and specially notched, inverted V-type disposal drain shown in (Figs. 1 to 5). Over 500 models are in use in California alone.

Several investigations concerning septic tanks have been conducted by experiment stations connected with the various state universities, but until recently there has been a

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Presented before the Farm Structures Division at the annual meeting of the American Society of Agricultural Engineers, at Asilomar, Pacific Grove, Calif., June 29, 1938.

Author: Agricultural engineer, The Pacific Lumber Company. (Fellow, A.S.A.E.)

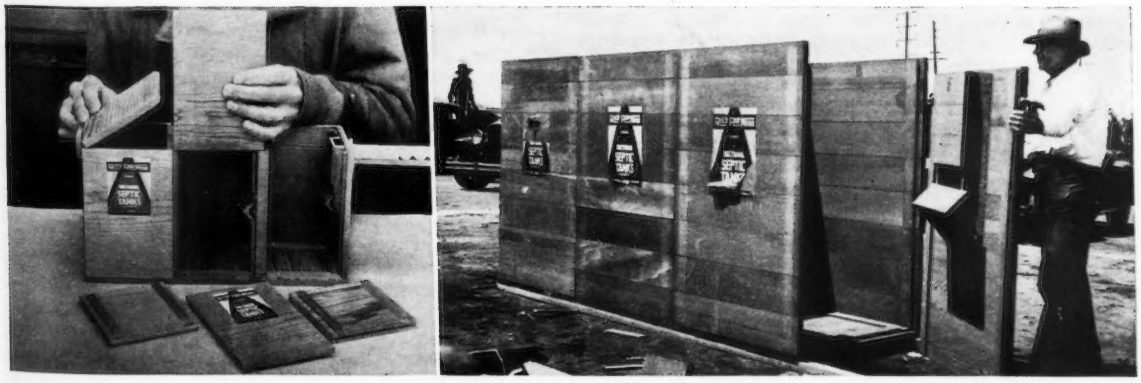


FIG. 1 (LEFT) A MINIATURE OR MODEL IS ONE OF THE MOST EFFECTIVE TOOLS THAT CAN BE USED IN ASSISTING ANYONE TO VISUALIZE A GIVEN STRUCTURE. FIG. 2 (RIGHT) PREFABRICATED SECTIONAL CONSTRUCTION REDUCES ASSEMBLY TIME TO A MINIMUM. COMMONLY USED TANK SIZES USUALLY REQUIRE LESS THAN ONE HOUR FOR ONE MAN WITH A HAMMER AND A HANDFUL OF NAILS

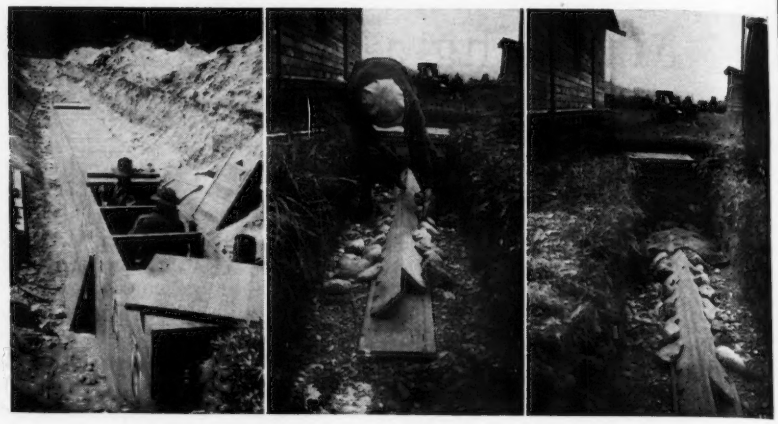


Fig. 3 (Left) Unit construction permits assembling a septic tank of any required capacity. This is a 4,000-gal unit assembled by one carpenter and two helpers in 3 hr. Fig. 4 (Center) Placing of notched disposal drain having four outlets per lineal foot. Fig. 5 (Right) The bottom board, with an average of one inch of fall in 50 ft, provides uniform distribution of effluent to the filter bed

lack of fundamental data on the factors affecting the design of simple septic tanks and effluent disposal systems.

Recently the Illinois Agricultural Experiment Station, in cooperation with the Illinois State Water Survey, undertook a study of tanks of simple rectangular design, which could be easily constructed by inexperienced workmen. Their investigations were continued for five years. During that time more than 1100 chemical analyses were made of effluent from experimental tanks.

Those of you who are interested in their findings should secure a copy of the Illinois station Bulletin No. 304. This is by far the most complete research work on the subject that I have been able to uncover.

The recommendations of the California State Board of Health conform very closely to those of the University of Illinois. The minimum size tank recommended for the average household for up to 7 persons is a tank with 4 ft of working depth, 3 ft wide and 6 ft long, with a 3x3-ft resettling compartment of the same working depth.

There is no universal agreement as to the number of gallons of sewage per person per day to allow in determining sizes, nor as to the most desirable retention period, but it is generally conceded that it is far better to err on the side of providing too much capacity than too little.

An undersize tank cannot hold the sewage a sufficient length of time to permit proper bacterial action. Such tanks accumulate sludge and release it into the effluent drain, clogging the system, at such a fast rate as to necessitate constant attention and frequent cleanings.

The smaller tanks not only require much more frequent servicing, cleaning, and removal of sludge, but they demand troublesome and expensive replacements and additions in the disposal field as well.

In undersize tanks and septic tanks of small capacities, the harmful effects on clarification and septic action, of disinfectants, grease, oil, brine, etc., are greatly increased, necessitating special care and provision such as grease traps or interceptors, which add to the cost.

It should be more generally recognized that *no tank can be any better than its drainage system.* It is almost impossible for anyone to prescribe definitely the required number of feet of disposal drain. Too many factors are involved, the principal one of which is absorptive quality of the top soil.

Our experience has been that it is more economical to proceed by the trial-and-error method, installing what may appear to be a reasonable amount of drain, but making definite provision to add more if and when it is found necessary.

From actual inspection by the University of California investigators in 1929 and 1930, of some 35 tanks and drainage systems in use for from 3 to 10 yr, the former recommendation of the University to use agricultural drain tile with open joints, for disposing of effluent from a septic tank, was abandoned due to the stopping up of open joints in tile drain where there is no provision to insure uniform distribution of effluent to the soil.

The latest University of California recommendation, Circular No. 82, calls for an inverted V-trough of redwood, or treated lumber, or a more expensive half-tile, placed on special shoes or sills.

Prior to the above findings by the University of California, the state board of health had also encountered similar difficulties in tile drain. They recommend as an alternate type of drain, in their Bulletin No. 56, an inverted V-type drain made of redwood.

For the prefabricated septic tank which our company is marketing, we merely took an accepted design, added a few refinements and improvements, and then sectionalized it, making it possible to assemble, in units of 3 ft, a septic tank of any required capacity.

Although a 3x3-ft tank with 4 ft of working depth and with a working capacity of some 225 gal could easily be assembled with any of the standard units, and although it could be marketed for considerably less than any of the so-called septic tanks of equal capacity on the market, I am proud to say that, as a matter of policy, we absolutely refuse to recommend, sell, or ship such a tank. We could not do so and keep faith with those who are charged with looking after public health and protecting water supplies.

Our company's smallest redwood sectional septic tank that is available is a 3x6-ft, two-section, single-compartment tank with a working capacity of 465 gal. This size conforms very closely to a former recommendation of the California State Board of Health, but the addition of a 3x3-ft resettling compartment is advocated. However, under comparatively light load, and particularly where there is ample area of porous, well-drained top soil in the disposal field, the 3x6-ft tank has a most enviable record of service. The resettling chamber may be regarded as a second line of defense, an additional factor of safety to insure more efficient chemical and mechanical operation.

The 3x9-ft three-section, two-compartment tank most suitable for the average household is regarded as a basic tank. It has a working capacity of 709 gal.

The average tank is easily assembled in an hour or two by unskilled labor. *(Continued on page 477)*

Soil Stabilization with Emulsified Asphalt

By Robert M. Morton

UTILIZATION of cheap local materials is the objective of every frugal engineer. "Soil stabilization" is the term used in the highway industry to designate many types of treatments of the local materials used for subgrade under pavements. The name is used generally to designate all of the various efforts now being made by highway engineers to increase the resistance of soil or aggregate materials to lateral flow when loaded. One soils engineer has described "stabilization" as being "any artificial work applied to any part of the natural soil foundation, substructure, or superstructure, which promotes permanent subsequent nonchange in its position, its volume, and its shape."

Most of the current methods of soil treatment include the addition of sand or rock particles in proper sizes and in sufficient quantity to create natural stability by friction of the particles. This is often supplemented by the mixing of deliquescent salts with the material, to prevent complete drying and subsequent dislodging of particles. Much work has been done in the mixing of low-grade asphaltic oils and tars with soils, either with or without refinements in grading of particles, in quantity sufficient to substitute bituminous bond for the binding action of the natural clay. Experiments have been made in the use of portland cement, in about half the quantity usually used with good aggregates, to make a low-grade concrete. Doubtless all of these methods have demonstrated some merit.

Soil stabilization with emulsified asphalt means the mixing of emulsified asphalt with clay-bearing soil or fine aggregate material, either with or without refinements in grading. Mixing requires the presence of sufficient water to wet and separate the fine clay particles of the soil or aggregate, thus permitting them to come into intimate contact with the asphalt in the emulsion. Mixing is followed by compacting and thorough drying of the mixture. The emulsified asphalt must be manufactured to avoid premature break when mixed with fine particles. When evaporation had reduced the moisture to 5 per cent or less, the soil or aggregate material thus treated is found to have permanent water-resistant properties, not possessed by the original material, and not imparted so consistently by any other method of treatment.

For those who are not familiar with asphalt in the emulsified form, it should be stated that these products contain from 55 to 60 per cent of pure asphalt in the form of microscopic globules, suspended in water, and maintained in delicate balance against coalescence before use by small amounts of emulsifying agents. Emulsified asphalts of stabilizing grades are liquid at atmospheric temperatures, and are used without heating. When applied to aggregates, the water evaporates, the delicate balance of the emulsion is upset, and the asphalt coalesces into films on the surfaces contacted.

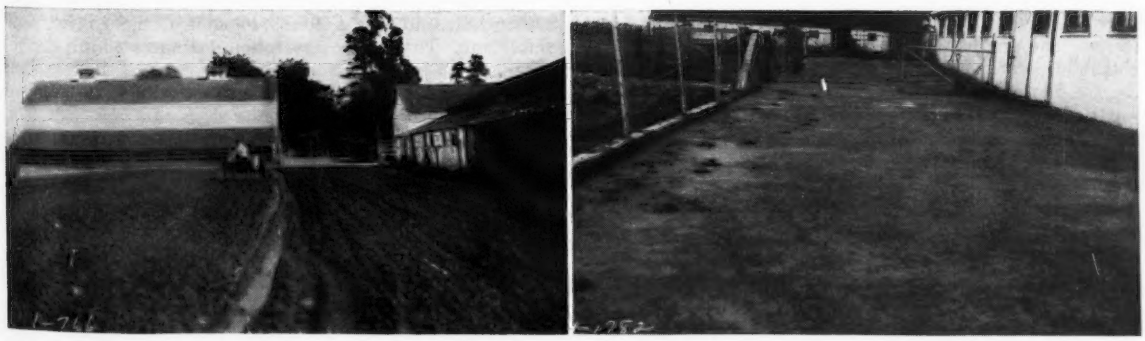
Stabilizing Disclosed by Research. During research on mixtures of Bitumuls with aggregates for road surfacing, our laboratories noted the greatly increased effectiveness of such mixtures, compared to mixtures made with pure heated asphalt or with cutback asphalt, when the aggregates contained fines and clay in excess of allowable minimums. Such mixtures were found to possess water-resistant qualities even when the quantity of asphalt was much below the amount required by common practice in designing asphalt pavements. When our laboratory studies were directed to combinations of emulsified asphalt with soils, it was found that mixing Bitumuls with almost any soil material created resistance to absorption of water after drying.

The quantity of emulsified asphalt required to impart water resistance was found to be only a fraction of the amount of asphalt in other forms required with the same soil to accomplish comparable results in waterproofing. For instance, a soil having fines which would require 10 to 15 per cent by weight of heated asphalt to bituminize and bond it, and to make it water repellent, could be rendered perceptibly resistant to water with as little as one per cent of asphalt in the emulsified form, added to a wet mixture.

Examination of soils with the soil hydrometer shows that the fines (passing the 200-mesh sieve) consist, first, of sand which settles quickly after the sample is shaken in water; second, of silts which are still finer grades of sand, and which settle, but more slowly; and, third, of fine clay particles which remain in suspension in the water after agitation, and which do not settle out upon long standing. The stabilizing effect obtained by using Bitumuls is the result of combination of the microscopic globules of asphalt

Presented before the Farm Structures Division at the annual meeting of the American Society of Agricultural Engineers, at Asilomar, Pacific Grove, Calif., June 29, 1938.

Author: Vice-president, American Bitumuls Co.



(LEFT) MIXING STABILIZED BASE FOR A CATTLE FEED YARD. (RIGHT) HOLDING PEN ON A DAIRY FARM, WITH STABILIZED BASE SURFACED WITH COLD-MIXED ASPHALTIC CONCRETE

(LEFT) HAND METHOD OF MOLDING STABILIZED SOIL BUILDING BRICKS. (RIGHT) A MODERN COUNTRY DWELLING MADE OF STABILIZED SOIL BRICKS

in the emulsion (from 1/10,000 to 1/25,000 in in diameter) with the equally fine clay particles.

Binding Action of Clays Caused by Adsorption of Moisture. Clay may be visualized as aggregate composed of particles less than 5/1,000 millimeter in diameter, a considerable portion of which are smaller than 1/1000 millimeter, or 1/25,000 in. Clays at atmospheric temperature are never free from moisture. Even when subjected to high heat they still retain moisture films around each particle. By the force of adsorption these moisture films are held tightly on each clay particle, and thus cause it to cohere to the moisture films on adjacent particles. Adsorption of water films is the only reasonable explanation for the strong bond which characterizes clay soils when wetted and then dried. The force of adsorption is one of the strongest of natural forces.

When dry-bonded clay materials are exposed to dampness, the new moisture unites readily with the adsorbed films on the clay particles, thus increasing the thickness of the films and destroying the force of adsorption. The thicker moisture films separate the particles of clay from one another and swell the mass, which becomes plastic, due to the lubricating effect of the heavy water films.

When asphalt in emulsified form is introduced into a wet mixture of clay-bearing soil or aggregate, the asphalt is substituted for some of the water which surrounds the fine particles. As drying progresses the asphalt is drawn out into microscopic films around each clay particle by the force of adsorption which accompanies the loss of water. Thus asphalt is made to replace most of the adsorbed water which would normally be present. After full drying the thin films of asphalt repel new moisture, and water resistance is created throughout the entire mass.

Untreated clay-bearing materials which are so easily affected by water are not suitable for foundations of pavements. The problem of the engineer is to employ materials obtainable at reasonable cost which are not susceptible to change in structural strength and volume when exposed to water. Treatment with emulsified asphalt of efficient stabilizing grade seems an excellent solution of this problem, and a solution which opens up, to all who have to do with soils, a new vista of valuable applications. For the farmer the process has many practical uses.

Amount of Emulsified Asphalt Required. Methods for determining the amount of emulsion necessary for efficient stabilizing have been arrived at by study of thousands of laboratory and field test results. The material is analyzed for grading by the wash sieve method. Fifteen per cent of emulsified asphalt, based only on the weight of the material which passes the No. 200 sieve, is the average required for efficient stabilization. For instance, if 100 lb of soil contains 20 lb which pass the No. 200 sieve, 3 lb of emulsion or 0.35 gal, containing only 1.65 lb of pure asphalt, would with most soils result in efficient stabilization. For practical reasons, 3 per cent is the minimum which we recommend for any soil, even if its content of material which passes the No. 200 sieve is less than 20 per cent. When it is realized that the total surface area of one pound of clay material less than 5/1,000 mm in size is calculated to be almost 13,000 sq ft, the microscopic thinness of the asphalt films which accomplish stabilization may be appreciated.

For most uses of stabilized material, the amount of fines in the soil material is controlled by admixture of coarse particles. With a fines content of 40 per cent, 100 lb of material would be stabilized with 6 lb of emulsified asphalt, containing 3.3 lb of pure asphalt.

Methods of Mixing. The emulsified asphalt creates no new problem in mixing. The water necessary to wet the soil may be added separately, or may be used to dilute the emulsion. Mixing is no more difficult than mixing plain water. Wetting the soil prior to adding the emulsified asphalt has the advantage of softening bonded groups of clay particles before the emulsion is introduced.

Mixing must be thorough. Hand mixing is often used on small jobs and for making stabilized adobe bricks. Concrete mixers are usually used for flooring jobs and tennis court foundations. Pug type mixers are best for permanent plant installations. Mixing on highway or street construction may be done by a modern travel mixer, or by disks, harrows, and road graders drawn by tractors. A plaster mixer is perhaps most efficient of all mixers, as thorough mixing can be done with the smallest amount of additional water, which shortens the period of drying.

Efficiency Tests of Stabilized Materials. Laboratory tests are included in specifications to control the efficiency of stabilizing. To measure absorption, cylinders 2 in in diameter by 4 in high are premolded of the material, both treated and untreated. After weighing the specimens are wrapped with cellophane which covers the sides and one end. The uncovered end is exposed to capillary water on a wet blotter for seven days, and the increase in weight measures the absorption. Typical test results usually show 10 or 20 per cent absorption on untreated specimens, and only from 0.6 to 1.5 per cent absorption on the treated specimens. Specifications usually require that absorption of treated specimens in seven days be less than 15 per cent of the absorption of untreated specimens of the material.

To measure stability, a test modeled on the Hubbard-Field stability test for asphalt paving mixtures is made. Specimens after exposure to absorption are fitted into a

mold of practically the same size, which has a one-inch diameter orifice in the bottom. Pressure is applied at the top of the specimen to force it through the orifice. Untreated soil materials, after seven days absorption of water, go through with little or no pressure, whereas treated materials require high pressures to extrude even the material at the bottom which has been in direct contact with the wet blotter. Pressures obtained in this test often reach 50,000 lb. The specification for stability adopted by the U. S. Bureau of Air Commerce and the U. S. Quartermaster Office requires a minimum pressure of 10,000 lb for the extrusion of the bottom ½ in.

Other tests include compression, which is made on cubes measuring 4 in on a side. The force required to crush a treated specimen is compared with the force required to crush a compacted dry specimen of the same material untreated. It is usually found that the treatment has added to the compressive resistance of the material. Soil materials usually develop from 200 to 600 lb per square inch. Well-graded, clay-bearing aggregates range from 500 to 1,000 lb per square inch in compression.

Uses of Stabilized Materials. At present the commercial uses of stabilizing with emulsified asphalt include foundations for airport runways, foundations for highways, streets and sidewalks, and stabilized bricks for building. Other uses are suggested and carried out from time to time, such as stabilizing clay cores in earthen dams, lining reservoirs to reduce seepage, and paving of water holes on cattle ranges. Stabilizing work has been done by the U. S. Soil Conservation Service using both soils and pit-run, clay-bearing gravels, for the making of small check dams.

Agricultural Uses. Many valuable uses of this process are possible in the agricultural field. There is already widespread interest in using building bricks of stabilized soil, as a modern substitute for the plain adobe construction of 100 to 150 years ago. Construction with stabilized soil bricks is ideally suited to the farmer's use, for he can make his own bricks using his own soils. Buildings with walls and partitions made of these bricks have many desirable qualities, including permanence. Another possible application on the farm is in the building of walls for terracing, in the paving of floors in tool sheds, hay barns, and chicken houses, and for foundations of drives, walkways, cattle corrals, feed yards, etc. When used on a drive or floor which is subject to constant wear, a light surfacing of rock or sand, mixed with cold emulsified asphalt, is all that is needed to make the improvement permanent.

Although we have not actively sought the farm market, some good-sized farm installations have been made in California in the paving of cattle corrals and feed yards. In these cases farm tractors and disk harrows were used to mix the emulsified asphalt with the natural soil which was previously softened by wetting. After drying the stabilized areas were surfaced with emulsified asphalt mixed with sand and gravel obtained nearby. The work has resulted in satisfactory pavements built at low cost. One large dairy ranch is carrying on an annual program of extending their corral paving. The owners are well pleased with the improvement and its reasonable cost. When the financial condition of agriculture improves, we fully expect that farmers in great numbers will turn to stabilizing of their own soils and gravel deposits with emulsified asphalt to build their own farm improvements at low cost.

Marketing a Prefabricated Septic Tank

(Continued from page 474)

A handful of nails and a hammer are all that are required, as the tanks are completely prefabricated.

For each 3x3-ft standard filler unit used to enlarge this basic tank, capacity is increased 243 working gallons.

I have now had practically 20 years of experience with redwood septic tanks. The first one installed under my supervision was in August 1918, on the Durham State Land Colony. It is still in service, and as recently as last February the owner reported this tank "in as good condition now as it was the day it was made."

There are literally thousands of this type of redwood tank, minus our special construction and sectional features, in satisfactory service for periods of up to 20 years and more. Provided only that the proper grade of material is used, one need have no thought that this type of tank is a temporary makeshift, or in any sense of the word a substitute for other, more expensive types of material.

In selecting redwood for similar duty it is not sufficient to specify or purchase, as is too often done, merely "California Redwood." The sapwood of no species is durable when in contact with the ground. Neither are some of the lower grades.

Redwood for all contact-with-ground uses should be of dense, sound, live, all-heart grade, free from sap, shakes, splits, or dead wood. This grade is "Irrigation Heart Redwood".

Our redwood disposal drain is prefabricated in 5-ft lengths. The individual pieces are notched, beveled, ploughed, and shiplapped, and are readily assembled by unskilled labor. This drain is of my own design, and I have now used it with great success for over 18 yr. With its four specially formed notches to the lineal foot, where open-jointed tile provides but one, and with its bottom board, which serves as a spreader to insure more or less uniform distribution of the effluent to the soil, I consider it far superior to tile drain of any type, with the one possible exception where a septic tank is equipped with a syphon or dosing chamber discharging intermittently into the drainage field, thus providing for intermittent rest periods.

Many of us are aware of many wholly unsatisfactory ordinances now in effect with reference to septic tanks and disposal drain systems, many of which appear to have been put together by the clip-and-paste method. A startling number, in my opinion, do more harm than good as they definitely make mandatory certain features that are contrary to recognized good practices. They defeat their own purpose.

We think it is most commendable that plumbing codes throughout the eleven western states are fast being revised, due to the efforts of the Pacific Coast Plumbing Inspectors' Association to include, under the standard plumbing code fostered and being promoted by this association, the requirements that septic tank plans and specifications shall be in compliance with the rules and regulations of the board of health. It seems most unfortunate that there is not more enforcement machinery to insure the installation of septic tanks of proper capacity. We believe, too, that as agricultural engineers we should do everything possible to develop closer cooperation between our respective state boards of health, or health departments, and our state universities.

Grass Silage

(Continued from page 472)

the season. The same land was then dragged and sowed to winter grain. In this way a run-out field was made to produce 15 tons of silage per acre its last year before reseeding. A number of well-informed cattle experts have expressed the opinion that grass silage has even more to offer corn belt farmers than farmers in the Northeast.

The unprecedented rapidity with which farmers have adopted such a radically new practice is explained by the fact that it offers a low-cost solution to two pressing farm problems. Early hay crops are almost universally hard to cure. Silos are empty at that season. The farmer knows that in eight years out of ten his pastures will dry up in midsummer. Grass silage provides an answer to both problems.

Once started with grass silage, its possibilities for winter as well as summer feeding begin to unfold. Weather hazards of haying are eliminated. The labor peak of hay crop harvest is flattened by ability to start cutting earlier in the season, by elimination of raking and field-curing operations, and by freeing the job from alternating rush and delay. Resulting feed is more productive than hay (20). It is faster, easier, and cheaper to harvest, store, and feed out (11). A higher protein silage than corn is produced at about 30 per cent less cost per ton, due largely to the reduction in plowing and cultivating expense (10). Less grain and concentrates are needed (13). It is a rich source of carotene and "grass juice factor" (new growth-promoting vitamin, as yet unnamed, recently isolated at the Wisconsin agricultural experiment station) (21).

As is indicated by the substantial array of references with which this paper is concluded, the somewhat sweeping claims here made for grass silage are well supported by experimental evidence. The research job is, however, by no means completed; nor is the work of extending present knowledge more than well started. The ramifications and importance of this development, plus the rapidity with which farmers are adopting grass silage, have occasioned a very real and pressing need for close cooperation between agronomists, animal husbandmen, and agricultural engineers in finding and broadcasting the answers to such practical questions as these:

1 What crops and which preservatives are best adapted to grass silage making in various areas?

2 To what extent can grass silage be profitably used to replace other feeds in the rations of various classes of livestock?

3 What changes in equipment and methods can be made to reduce grass silage harvesting costs?

4 How and of what should barns be built when hay crops are to be stored as silage?

5 Can 5 or 7½-hp electric motors be used to store grass silage?

6 To what extent can the growing of grasses for silage be substituted for more expensive soil conservation measures?

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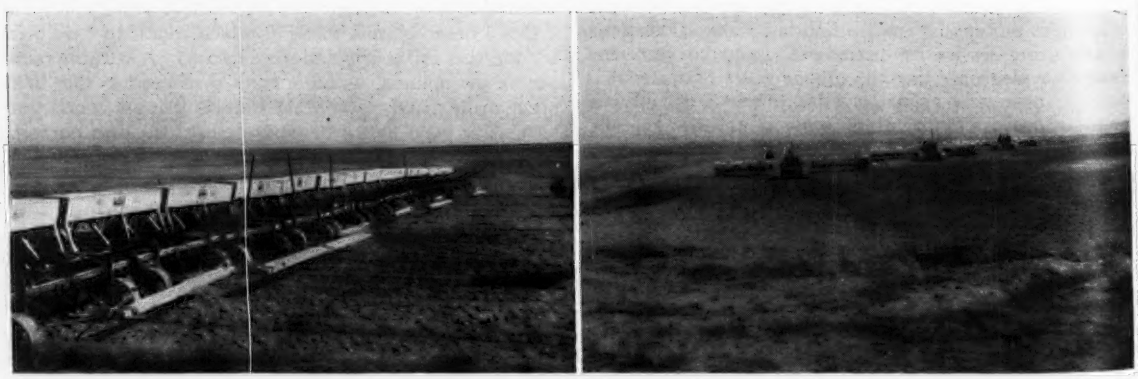


DRY-FARMING SEEDING EQUIPMENT

Application of the Dempster press drill to dry-farming conditions in Idaho. Operation on a 1600-acre field of special malting barley owned by Jess Hays of Idaho Falls. Weeding, seeding, and leaving a cloddy seedbed prevent wind erosion and plant blowing. Three units covering a 120-ft width seeded 93 acres the first round. The result of this application is under observation

A New Demand for Ventilating and Heating Poultry Houses

By J. C. Scott

THE PRACTICE of keeping laying hens in individual laying cages, commonly referred to as hen batteries, is rapidly expanding in western Washington. Some reasons for expansion of this practice are as follows:

1 Ease of keeping individual laying records.
2 If the house is of correct dimensions, nearly twice as many birds can be housed as where they run on the floor.
3 Reduced spread of disease.
4 Facilitates exact culling.
5 Timid birds not interfered with by bullies.
6 Replacement hens are not run over or interfered with by the rest of the flock.

In keeping a large number of hens in rooms, the problem of sufficient ventilation is intensified. The problem becomes more serious in the colder weather because opening windows or ventilators produces drafts on the birds close by, and it is impossible for the birds in the individual cages to get out of the drafts. Also exercise of the birds is practically eliminated. Even though it were possible to eliminate severe drafts on birds close to windows, yet to get sufficient air into the room for this larger number of birds develops a serious problem in connection with low temperatures in the house.

In the fall of 1936, S. A. Sween, poultryman near Woodinville, Washington, who has for years made a practice of keeping all layers in individual cages, presented this problem of ventilation and heating in the battery room to the agricultural engineering department of our company. Our problem here was to introduce sufficient air into the room and at the same time eliminate drafts from all parts of the room, and produce an even temperature between the ceiling and the floor.

To get these results, we planned a setup to use a blower fan operated by an electric motor set over the ceiling of the poultry room. An opening was cut in the middle of the room at the ceiling. The air entering the room was baffled so that there was no severe draft on any of the birds at any time. All doors and windows were closed so an air pressure of about $\frac{1}{2}$ in was developed inside of the room. With this pressure there was sufficient air escape, through cracks and crevices around the doors, so that there was a lack of odor, no damp walls as in the other buildings using window openings, and a difference in temperature between the floor and ceiling of only 3 F (degrees Fahrenheit). Temperature was maintained at 50 F or higher. The result was healthier and more comfortable birds, and the air temperature at 50 F solved the water-warming problem. There was no slump in egg production during the entire winter, as was experienced in the other houses using the old system of window ventilation.

Presented before a joint session of the Farm Structures and Rural Electric Divisions at the annual meeting of the American Society of Agricultural Engineers, at Asilomar, Pacific Grove, California, June 30, 1938.

Author: Agricultural engineer, Puget Sound Power and Light Co. Mem. A.S.A.E.

Description of the Unit. The ventilating and heating unit, which is placed on top of the ceiling, consists of a multi-blade blower directly connected to a 1725-rpm motor. The blower and heater rest directly on the ceiling joists. The discharge from the blower is placed so that it points down through the ceiling in the center of the room. This blower furnished 1100 cu ft of air per minute and is best suited for a room of 24x40 ft, holding 550 chickens. This unit is equipped with a 2500-watt heater and sells for $45.

Damper. The air is taken into the blower from the attic where there are openings for outside air to enter. A damper in the air intake of the blower is attached to a regulating lever long enough so it can be operated from the room below. Care must be exercised in using the damper, as it is necessary to keep a slight air pressure in the room in order to maintain an even temperature between the ceiling and floor.

Baffle and Heating Unit. Under the opening in the ceiling where the air from the blower enters the room is placed a round pan with straight sides about 2 in deep. In this pan are placed round, sheath-type electric-heating units.

One of the most important features in the successful operation of this ventilation system, in getting an evenness of temperature at the floor and ceiling without drafts, is that the top edge of the pan baffle should not be more than $1\frac{1}{8}$ in from the ceiling. As this pan acts as a baffle to force the air along underneath the ceiling, it is larger in diameter than the opening where the air comes out.

Our first trial of this system of heating and ventilation of the poultry house was made on the Sween farm in 1936-37. The unit was installed in a 24x30-ft unit poultry house. These are not the right dimensions for the economical use of batteries, as there are only 216 hens in this house. It was too narrow to receive the maximum number of cages. Had it been 4 ft wider, 108 more cages could have been accommodated. This unit was operated from December 1, 1936 to January 31, 1937, with an average current consumption of 12 kwh per day. During this period of 62 days the outdoor temperature was below freezing 49 days, and part of the time as low as zero.

BABY CHICK CABINET BATTERY BROODER

After our successful experience in maintaining an even temperature and with excellent ventilation of the individual laying cage or battery room for hens, a cabinet for battery brooding of baby chicks was constructed with the idea of using the same heating and ventilation system as that used with the hens. The only difference in the setup was that a small opening was made, 6 in square, in the wall near the floor at each corner of the room. Dampers were placed in the openings so the amount of air change could be regulated, the object being to get sufficient ventilation to avoid bad odor in the room. This system also eliminated numerous individual heaters and thermostats in each battery section. In our tests there was practically no difference in temperature of the top battery sections near the ceiling and the lower ones near the floor.

Description of Battery Cabinet. The cabinet was 10x9 ft 7 in, with ceiling height of 6 ft 6 in, double-wall construction, with shavings between the walls. This double-wall construction and installation may not be necessary where tight construction is used and where the cabinet is placed in a well-built building. The same small heating and ventilating unit as used with the hen battery room for 550 laying hens, was used in the battery for baby chicks. This unit, driven by a ½-hp, 1725-rpm motor, delivering 1600 cu ft of air per minute, over a 2500-watt heater, was sufficient for a battery cabinet much larger than the one used, under climatic conditions west of the Cascades.

When the cabinet room was full of chicks, we found that 25 air changes per hour were sufficient and made for an extremely healthy condition of the chicks, as compared with the chicks raised in ordinary battery rooms. Mr. Sween, the poultryman who used this cabinet, states that the results of this type of cabinet battery were healthier chicks and that the chicks, after being taken from the battery, developed faster than any chicks he had raised under the brooder. Current consumption starting on February 24, for 23 days averaged 77 kwh per day.

The cabinet room had a capacity of 3,000 chicks but at no time were there more than 2,000 chicks in it, resulting, of course, in the use of more electricity than if the room had been filled to capacity. Temperature was kept at 90 F during the entire 23 days.

After the brooder was shut down for a few days only 6 hr were required to bring the cabinet room from 45 to 90 F, even though the room was empty.

The Use and Design of Settling Basins

By George Burnet

THE CCC drainage camp located at Missouri Valley, Iowa, in cooperating with the various drainage districts in the rehabilitation of their ditches, has been confronted with a serious silting problem. The ditch water is carried from the hilly land at rapid velocity and when the bottom land is encountered, with its low gradient and slow velocity, a portion of the sediment carried in suspension is deposited. Rapid filling of the ditches results, which lowers their efficiency and requires costly cleanouts.

In an effort to stop this damage, settling basins have been constructed which are located at the upper end of the ditch where the hill water enters the bottom land and a change of gradient occurs. They are constructed by surrounding a field, adjacent to the ditch, by levees, using what natural barriers exist, and placing an inlet at the upper end and an outlet back into the ditch at the lower end. The inlet is provided by a cut in the levee approximating the size of the drainage ditch and the outlet by one or more pipe of approximately 48 in diameter, equipped with floodgates. A safety spillway is also constructed in the levee on the side of the settling basin for the return of flood water to the ditch in case of excessive rainfall and runoff. It is constructed by lowering a 100-ft section of the levee to an elevation 2 to 3 ft below the lowest elevation of the levee in the settling basin. Although considered an essential feature, no flood has, as yet, overtopped one of these safety spillways. As the ditch bottom is usually 5 to 6 ft below the ground elevation in the settling basin, it is necessary that a dam be constructed across the ditch just below the inlet into the basin. It is built on a 45-deg angle with the center line of the ditch and forces the water into the basin. Through the dam is placed a 24-in pipe for dry weather flow in the ditch.

Seven of these settling basins have been constructed to date as follows:

The Epperson basin on the Willow ditch, constructed in 1932. It comprises 63 acres and is located on the north edge of Missouri Valley, Iowa.

The McIntosh basin on the Willow ditch, constructed in 1934. It comprises 112 acres and is located 2 mi north of Missouri Valley, Iowa.

The Hughes basin on the Willow ditch, constructed in 1932. It comprises 138 acres and is located 5 mi north of Missouri Valley, Iowa.

The Myers basin on Allen Creek, constructed in 1933. It comprises 260 acres and is located 7 mi north of Missouri Valley, Iowa.

The Schwertly basin on Allen Creek ditch, constructed in 1933. It comprises 110 acres and is located 5 mi northwest of Missouri Valley, Iowa.

The Teeter basin on the Allen Creek ditch, constructed in 1933. It comprises 146 acres and is located 10 mi north of Missouri Valley, Iowa.

The Yost basin on the East Soldier ditch, constructed in 1934. It comprises 44 acres and is located 16 mi northwest of Missouri Valley, Iowa.

These settling basins have all been successful, but a big difficulty lies in the fact that the districts cannot legally construct a dam across a ditch to force flood water into the basin. This has been done in all cases except the Teeter basin, where the ditch bottom is of higher elevation than the ground level of the basin. The portion of the ditch above such dams requires cleaning out almost yearly. A typical case is the Myers basin. It was located on the Allen Creek ditch at a point 3.5 mi below the upper end of the ditch and 2 mi below the point where Allen Creek enters. The basin functioned in a very satisfactory manner and stopped silting of the 13.5 mi of ditch below it, but the 3.5 mi of ditch above the basin silted in so rapidly that it required almost yearly cleaning out. In 1936 the affected landowners objected and had the dam removed. The settling basin ceased to function and in the year 1937 the 13.5 mi of ditch below it filled in approximately 3 ft.

There is a very apparent need for additional study on this problem. At one time a bill was drawn up for submission to the state legislature, legalizing the placing of dams in ditches when necessary in the construction of settling basins, but it was prepared too late to be presented and was not reconsidered. However, there are many construction features that need additional study and demonstration, among them being the correct location, size of basin, size and design of spillway, and the further use of dams. Although very effective where used, it appears that settling basins will not be used extensively in this area until certain legal matters and engineering problems can be satisfactorily settled.

A contribution of the A.S.A.E. Committee on Land Drainage, 1938.

Author: Associate drainage engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Mem. A.S.A.E.

Special Sugar Beet Production Machinery

By S. W. McBirney

THE MOST noticeable difference between sugar beet production on the Pacific Coast, particularly in California, and in the other sections of the United States is the large-scale nature of the enterprise here. According to the 1935 Census, the average acreage of sugar beets per farm reporting was 75.7 in California as compared with 28.2 for Nebraska and Wyoming, 26.2 for Montana, 22.2 for Minnesota, 21.2 for Colorado, 10.7 for Idaho, 9.9 for Ohio, 8.4 for Michigan, 7.9 for Utah, and 5.1 for Wisconsin.

This large-scale production necessitates the use of larger sizes of power and machinery units. Most sugar beet growers plan their operations around a tractor of about 30 dhp, usually tracktype, of approximately 40 to 44-in tread, as such a tractor is well adapted to beet harvest. With these tractors are used four or five-bottom plows for deep, dry-land plowing, heavy 10 or 12-ft floats, heavy 10-ft double-disk harrows, and varying width and weight spring-tooth or spike-tooth harrows. All of these are common to other crops and other sections of the country.

The multiple beet planter and cultivator units, however, are not often found outside of this section of the country. In our districts practicing flat planting, most of the older planting outfits and some of the newer ones are multiple units of three or four four-row machines planting 12 or 16 rows at once. Many of the newer planting units consist of two six-row planters pulled side by side, as these units provide better utilization of labor (Fig. 1).

The usual row spacing is 20 in, though there seems to be an increasing tendency to use alternate spacings of 14 and 26, or 16 and 24-in widths. With the alternate spacings the planter and cultivator set-ups provide for running tractor wheels or tracks in the wide spaces. Irrigation furrows are run only in the wide spaces and can be made larger, thereby confining the irrigation water somewhat better in the rows, particularly where the ground level is slightly uneven. With 20-in rows, irrigation furrows are run in every space.

Cultivators are used in multiple units to match the planting. Three four-row cultivators, hitched with the center one behind the other two, or two six-row cultivators hitched abreast or staggered, are used on the twelve rows planted together.

Presented before the Power and Machinery Division at the annual meeting of the American Society of Agricultural Engineers, at Asilomar, Pacific Grove, Calif., June 28, 1938.

Author: Associate agricultural engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Mem. A.S.A.E.

Sugar beet harvesting methods and equipment are different than those in other sections. The typical beet lifter used is a two-row implement with a chassis carrying a subsoiler standard, to the bottom of which are attached two horizontal shares, or beet wings as they are called. The subsoiler standard goes down between two rows, and the shares, extending outward under the rows, cut off the lower tips of the beet roots and lift the whole soil mass, thereby loosening the beets from the soil. These lifters require tractors of about 25 to 30 dhp and suited to the row widths. Short track plates are necessary to prevent damage to the large beets.

Beets are not pulled and piled or windrowed before topping, as in most sections. Here the toppers pick up the beets from the row either with the hook on the end of the beet knife or with the empty hand; top them, allowing the tops to fall anywhere, and toss the roots from eight beet rows into a windrow.

The beets are loaded onto the trucks from the windrows by hand (Fig. 2). The truck moves down between two windrows and is loaded from both sides, eight to ten men forming a loading crew. The beets are not forked on as they are in most sections, probably because the ground is so hard and dry at harvest time, which usually begins early in July, that it breaks up into large hard clods which will not smooth down well to form a strip from which the beets can be easily forked. Then, too, many of the clods would be forked up with the roots and would not sift out through the beet fork.

The beet tops are usually pastured in the field. Temporary fences are strung around harvested portions of the fields and herds of beef cattle, or occasionally sheep, are run on the field until the feed is cleaned up, much the same as corn is hogged off in the Middle West. The tops from 15 to 20-ton beets will give around 50 to 60 cow-days of pasturage per acre.

Most of the beets are trucked to dumps where they are loaded onto railroad cars for transportation to the sugar factories, or are hauled by the truck directly to the factory. The barge beet dumps (Fig. 3) of the Sacramento-San Joaquin River delta district, however, are new to those who come from other sugar beet areas. Most of the beets from the islands of this delta country are loaded onto barges which are towed through the channels or sloughs to the sugar factory.

These peat soil islands, originally reclaimed from marshland and often below the water level of the channels between them, with their winding levee roads and old fer-

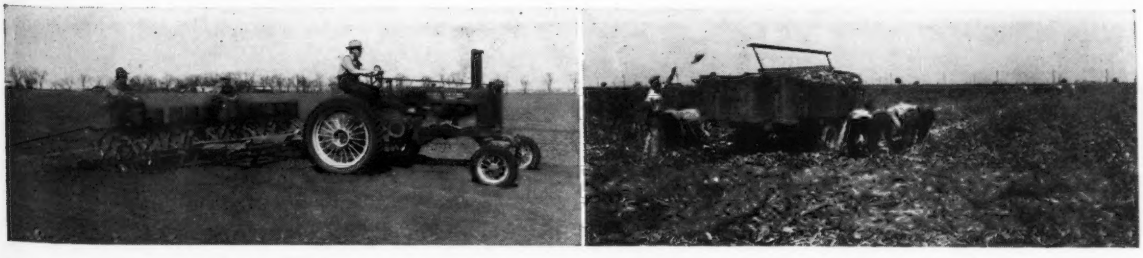


FIG. 1 (LEFT) PLANTING SUGAR BEETS WITH TWO-ROW PLANTERS PULLED SIDE BY SIDE. FIG. 2 (RIGHT) LOADING SUGAR BEETS FROM WINDROWS AS DONE IN CALIFORNIA

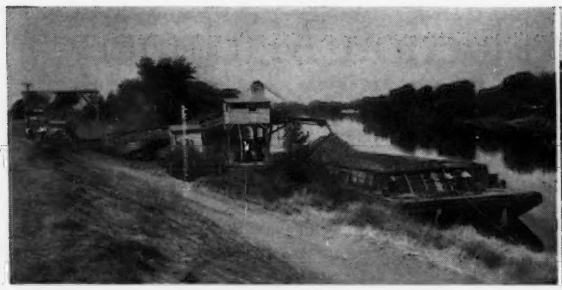


FIG. 3 (LEFT) HOLLY SUGAR COMPANY BARGE BEET DUMP AT HOWARD LANDING, NEAR RYDE, CALIFORNIA. FIG. 4 (RIGHT) BED PLANTING SUGAR BEETS WITH A THREE-BED SLED PLANTER

ries, their occasional fringe of pear trees whose tops are level with the levee roads, and their large sugar beet, asparagus, celery, potato, onion, flint corn, and occasional barley fields, produce many of California's sugar beets. Irrigation water is siphoned from the river channels or sloughs and the drainage pumped back. The soil is so porous that irrigation water seeps from ditches 50 ft or more apart. Some of the soil is such a pure peat that it will burn, and care must be exercised to keep fires from starting. One section is called Holland land because, like Holland, it is reclaimed land and is protected from overflow by its levees.

Sugar beets are planted on a flat seedbed in most sections of the United States. The method of ridge or bed planting found particularly in the Salinas Valley in California, where several thousand acres are grown in this manner, is a notable exception. Two rows of beets are grown on each flat-topped bed formed from listed ridges. Bed planting is also used for head lettuce, and in fact was adapted from the lettuce industry to sugar beet growing.

The chief advantage of bed planting is in connection with irrigation, as it facilitates keeping the water away from the crowns of the plants and helps to keep the irrigation water confined to the furrows, particularly over slightly uneven ground without much slope. Other advantages are that it enables irrigation necessary for seed germination; it decreases the danger of covering young beets in furrowing; it hastens drying out and germination on early plantings followed by wet, cold weather; and there is less tendency for crust formations following heavy rains. Disadvantages of this cultural method are that it is somewhat more expensive; it requires specialized equipment not usually available; it sometimes involves difficult and expensive methods for controlling weeds; it is not adapted to cross blocking or cross cultivation; and it is not well adapted to large-scale farming as planting units larger than six rows (three beds) have not proven practicable.

Ridges are usually listed on 40-in centers and are later shaped to beds about 22 to 24 in wide on top, about 6 in high and with the two beet rows on the bed spaced 14 in apart. This gives alternate 14 and 26-in rows, or the same number of rows as with the regular 20-in rows.

Following dry plowing and floating in the fall, with perhaps chiseling or some other operations before floating, the ground is ridged with ordinary lister bottoms on a chassis equipped with markers. The rough ridges with their large, hard, dry clods or chunks lie through the winter rains, taking moisture and weathering down.

In the spring the weathered ridges are harrowed to flatten them down somewhat and kill weed growth which may be starting.

Occasionally when winters are mild and the springs are wet, so that spring work is delayed, weeds will get started on the ridges and considerable working is necessary to clean them up. Sometimes they get so bad that the ridges have to be worked down completely to get rid of the weeds, and then furrowed up again.

Planting is usually done with specially made sled bed-shapers and planters (Fig. 4). Shovels or half shovels on the sled runners open up the furrows again, while a cross board ahead of the planter unit strikes off the top of the bed to the desired height. *(Continued on page 484)*

FIG. 5 (LEFT) BED PLANTING SUGAR BEETS WITH A LARGE, WHEELED HILL PLANTER. FIG. 6 (RIGHT) TWO-ROW, DOUBLE-STANDARD, OFFSET-POINT BEET LIFTER FOR BEETS GROWN ON BEDS

Big Machines for Big Precision Farm Jobs

By B. L. Hagglund

SINCE the days when Paul Bunyan and his big blue ox, "Babe," moved from the Great Lakes timber areas to the fir logging regions of Oregon and Washington and the redwoods of California, the demands of men tilling the soil and harvesting the crops of farm and forest in the West have been for bigger and stronger implements and tools.

The giant harvesters of Holt and Harris; the colossal early-day steam wheel tractors of Holt, with their wheels covering a width of 36 ft (18 ft each); the heavy-duty tillage tools of Killefer, Brenneis, Towner, and Dyrr; and the great land-leveling scrapers of LeTourneau are typical examples of western manufacturers' efforts to satisfy the western farmers' demands for more strength and greater size.

In addition to the demands for strength and size, irrigation, high-priced land, and high-priced crops have created a demand for tools that will do a precision type of job in seedbed preparation.

Before such fields can be finished, however, strong, rugged scrapers, land levelers, and floats play an important part in moving large quantities of dirt to the points where needed to establish accurate grades to make irrigation uniform and economical. A good many farmers own scrapers of from 3 to 20 yd capacity. LeTourneau's large carrying scrapers used today throughout the world in all forms of dirt moving, had their origin in a western shop where the owner was trying to solve western farmers' land-leveling needs.

The heavy-duty blade grader and its offspring, the terracer, play an active part on many western irrigated farms in the building of irrigation and drainage ditches, and in the building and knocking down of checks and borders.

A large-scale, blacksmith-built moldboard plow capable of throwing up borders 3 ft high, or making irrigation and drainage ditches, is used in the Tulare Lake area, where water is handled in very large heads.

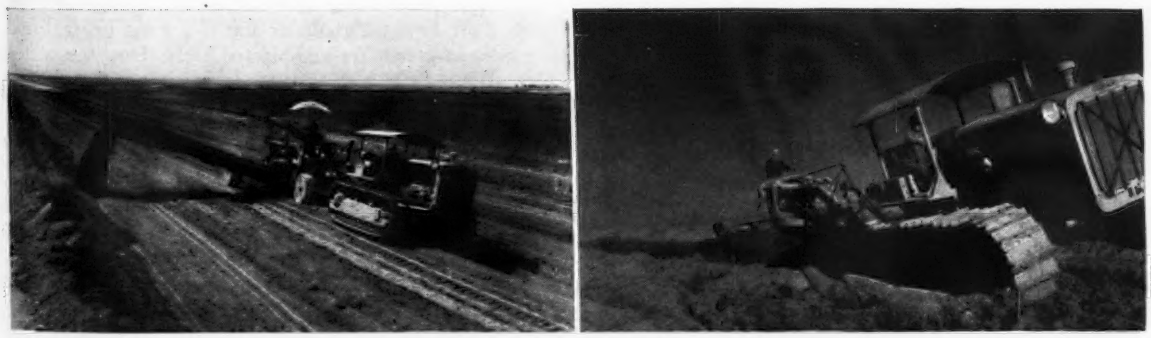
Most of you, perhaps, think of the elevating grader as a road building tool, but in California the sales of such units are almost entirely to farmers for building levees in land reclamation work. The elevating grader with its strength, ruggedness, and great dirt-moving capacity is an important farm tool in the Tulare Lake area.

While great strength is needed in some areas, a tool of shallow-working design, but of great width, is required in others. The farmers and the engineers of the Northwest have combined ideas in destroying Russian thistle by spreading fire with a harrow and a tractor.

Probably in no farm tool ever designed in the West has the builder been required to keep his imagination in tune with the ideals and activities of Paul Bunyan and his big

Presented before the Power and Machinery Division at the annual meeting of the American Society of Agricultural Engineers, at Asilomar, Pacific Grove, Calif., June 28, 1938.

Author: District representative, Caterpillar Tractor Co. (Mem. A.S.A.E.)



(LEFT) IN CALIFORNIA THE ELEVATING GRADER IS SOLD ALMOST ENTIRELY TO FARMERS FOR BUILDING LEVEES IN LAND RECLAMATION WORK. (RIGHT) A POWER-CONTROLLED BLADE GRADER USED IN BUILDING A CANAL IN THE TULARE LAKE (CALIFORNIA) BOTTOM

(LEFT) BUILDING A DITCH (CALIFORNIA) FOR THE IRRIGATION OF COTTON. (RIGHT) FIVE TRACTORS PULLING A HUGE POST BROS. PLOW 6-FT DEEP TO TURN SAND UNDERNEATH AND GOOD BLACK SOIL ON TOP ON WASHED-OVER LANDS

blue ox so much as have Post Bros., of Santa Ana, California, in building their "colossal, gigantic and stupendous" plows.

With their special plows, Post Bros., farm contractors and builders of special tools, turn sand underneath and good black soil on top on washed-over lands. Specifications and prices on these plows follow:

Depth of cut, ft	Weight, lb	Power requirements, hp	Price
2	2,760	60	$ 500
3	6,000	90	1,575
4	8,000	150	1,800
6	15,000	300	
		450	3,450

Deep plowing of many of these washed-over lands has doubled lima bean yields. Post Bros. charge $45 per acre for 6-ft plowing, $25 for 4-ft plowing, and $15 for 3-ft plowing.

Combines had their start in the West, and hillside combines designed for the extreme slopes of the Northwest and California have long been used. Extreme hillside combines have the ability to level from both sides to handle grades up to 55 per cent on the up side, and 35 per cent on the down side. Combines designed for Western hills employ the cell belt method of separation so as not to be so greatly affected by up-and-down-hill movement of the combine.

Management and organization of farm machinery on western dry-farmed ranches probably play a more important role in failure or success of the rancher than is true on more diversified farms where many other factors are of equal influence. Here in the West we have many third-generation tractor farms. While many successful dry-land farmers can be cited, I would here like to call attention to one man who has done an unusually fine job managing his farm equipment. Bill Foss, of Madera County, California, with a string of plows, drills, harrow, a 24-ft combine, and one 60-hp diesel tractor, does a fine job of farming 6200 acres of dry-farmed wheat and barley land, half in crop and half in fallow. This huge job with one tractor is only possible because of a sound program of managing power and implements.

Those of us interested in agricultural engineering owe much more than the world will ever know to Bill Foss and his kind for the ideas and suggestions they have given us all in the practical application of our products to the job.

Special Sugar Beet Production Machinery

(Continued from page 482)

The planter units are usually garden-type seeders with individual drivewheels and are mounted on the sled so that each unit floats independently of the others.

Sometimes field planters are mounted on the sled bed shapers in such a way that the wheels may run along the tops of the beds to drive the seed-feeding mechanism.

Sometimes the beds are shaped independently of planting and are planted with conventional planters provided with larger wheels (Fig. 5) or raised in some other way to compensate for the bed height.

Cultivation of bed-planted beets, or other crops, requires some special tools. Ordinary weeder knives or duck feet are used on the flat tops of the beds. Special curved or crescent-shaped knives have been developed for cutting the weeds along the sides of the beds. Furrowing shovels in the furrows clean up the weeds there and throw the soil back up against the sides of the beds.

The single subsoiler standard type of beet lifter or plow, with short beet wings under the two rows being lifted, works satisfactorily for bed-planted beets. However, a new type of beet lifter with two standards having inward offset points has been developed for bed-planted beets and is said to be lighter in draft, as well as able to go deeper for long beets. This same type of lifter is also being adapted to flat planted, 20-in row beets.

There is some tendency for bed-planted beets, especially if well lifted, to roll out into the furrows and be crushed by the tractor tracks on the next trip through the field. Arms back from the standards of the double-standard type of plow prevent this (Fig. 6). Spacer blocks are often used between the tractor track plates and the links, to raise the tractor to give ample clearance under the crankcase or drawbar.

Energy Requirements and Safety Features of Electric Insect Traps

By J. R. Tavernetti and J. K. Ellsworth

DURING the past few years, the use of electrocuting devices to kill insect pests has become a common practice. These devices consist of an electrocuting grid of parallel wires or bars connected to a high-voltage, low-current transformer. The insect, in passing between or lighting on the bars, causes an arc with a resultant passage of current through its body. For controlling flies the electrocuting grid is usually made in panel form and placed over doors and windows, or in a horizontal position over a box in which the dead flies collect and act as an attractant for others. For controlling insects that are attracted by light, the grid is usually made as a circular cage with vertical bars in which a light is placed.

Since these devices employ high voltage and exposed conductors, and may be located where they can be contacted by humans, they may be hazardous unless protected by a guard or unless the current is low enough to be harmless. To protect them by a guard is difficult, as it not only adds to the cost and bulkiness of the trap, but may inhibit the insects from reaching the electrocuting grid. With small insects the guard would be feasible, but with insects such as the tomato horn worms, which have a wing spread of from 4 to 5 in, it would be quite difficult to use a guard that would give protection and still not be excessively bulky. Limiting the current to a value that would be harmless seems to be the simplest means of eliminating the hazard. To accomplish it by this means, however, two problems must be solved. One is the determination of the limit of current that is safe for humans, and the other is the determination of the current and voltage necessary for the efficient operation of the device. Solving the former is difficult because direct experiments cannot be conducted. However, an approach has been made by using animals and by determining the amount of current that can be voluntarily tolerated by humans. Experiments to determine the latter were conducted and reported by Dalziel[1]. He reported that on tests with 56 men between 20 and 40 yr of age, and using 60-cycle current, 13.9 ma (milliamperes) was the average and 22 ma the maximum tolerable current from hand to hand, and that 12.6 ma was the average and 18 ma the maximum current which could be tolerated, and still be able to release a conductor grasped by the hand. He also reported that the amount of tolerable current was dependent on the frequency but independent of the voltage.

To determine the electrical requirements necessary for efficient operation of insect electrocuting devices, a series of laboratory experiments were conducted. The insects used, which were raised in the laboratory, were the green-bottle fly (*Lucilia sericata*) and potato tuber moth (*Phthorimoea operculella*). These insects are relatively small, having a wing spread between ¼ and ½ in.

Method of Conducting Experiment. Fig. 1 shows the set-up that was used to conduct the experiments. It consisted of an electrocuting grid connected in series with a milliammeter, water-tube resistor, and a high-voltage transformer. The high-voltage transformer was connected to an auto-transformer, which in turn was connected to a

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Authors: Respectively, assistant agricultural engineer (Mem. A.S.A.E.) and assistant in entomology, University of California.

[1]Dalziel, C. F., Danger of Electric Shock. Electrical West, Vol. 80, No. 4, (April 1938).

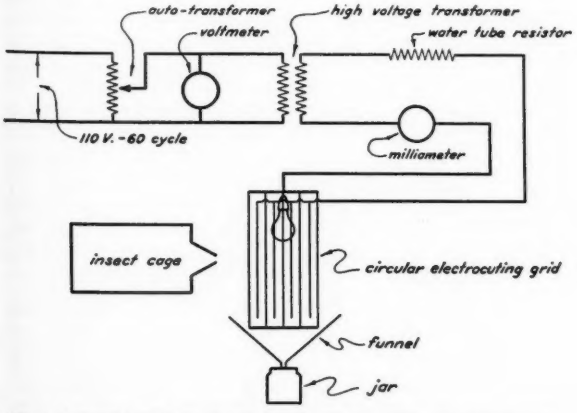
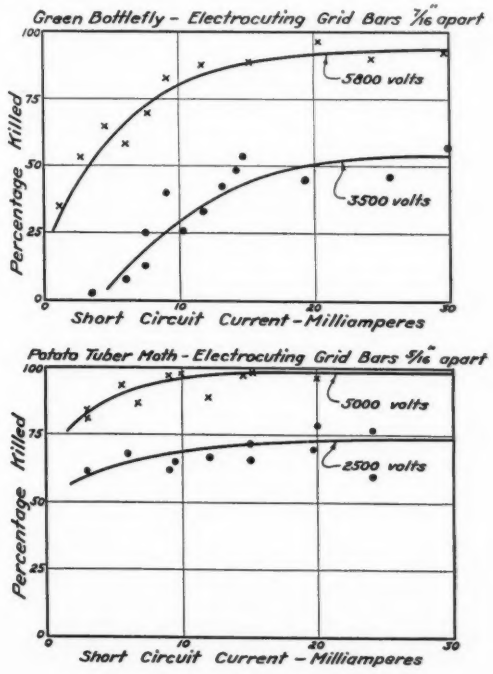


FIG. 1 (ABOVE) WIRING DIAGRAM OF SET-UP USED TO DETERMINE ELECTRICAL REQUIREMENTS OF INSECT ELECTROCUTIING DEVICES. FIG. 2 (RIGHT) TYPICAL CURVES SHOWING PERCENTAGE OF INSECTS KILLED AT DIFFERENT CURRENTS AND VOLTAGES



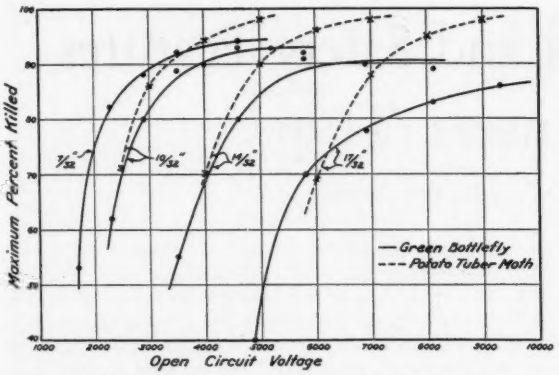


FIG. 3 MAXIMUM PERCENTAGE OF INSECTS KILLED AT VARIOUS VOLTAGES AND DISTANCES BETWEEN GRID BARS AND UP TO A CURRENT OF 30 MA

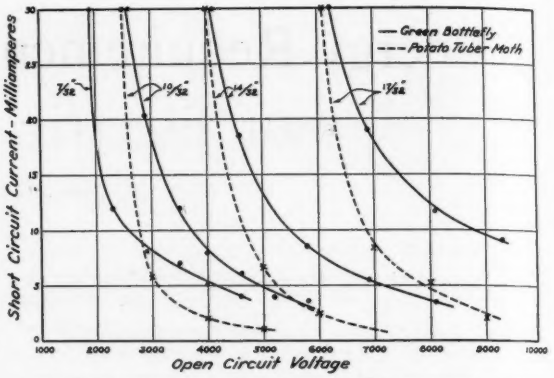


FIG. 4 CURRENT AND VOLTAGE NECESSARY TO OBTAIN A 75 PER CENT KILL OF INSECTS BY ELECTROCUTING ON GRIDS WITH VARIOUS SPACING BETWEEN BARS

110-volt, 60-cycle circuit. The voltage on the electrocuting grid was regulated by changing the primary voltage on the high-tension transformer by means of the autotransformer. The current on the grid was regulated by means of the water-tube resistor. Four different electrocuting grids were used, each being a circular cage 7 in in diameter and approximately 15 in high, with 3/32-in diameter vertical bars. The space between bars was 7/32, 10/32, 14/32, and 17/32 in, respectively, for the four different grids. A mazda light in the center of the cage was used to attract the insects.

Two different transformers were used, one with a rating of 110-volt primary and 12,000-volt, 60-milliampere secondary, and the other with 110-volt primary and 5000-volt, 60-milliampere secondary. The transformers were calibrated to obtain both the open-circuit secondary rms (root mean square, or effective value) and crest voltages with primary voltages from 0 to 135 volts. The crest factor was between 1.45 and 1.50 for both transformers.

The water-tube resistor consisted of a glass tube one inch in diameter and 5 ft long, filled with water. The resistance was varied by means of a sliding rod through a cork in the end and by changing the salt content of the water.

In conducting the experiments, the open-circuit voltage and the short-circuit current on the electrocuting grid were set at a predetermined value. The insects were released one at a time from a cage through a glass funnel in the end and allowed to fly a distance of about 6 in into the grid. They were caught in a jar by means of a funnel under the grid and allowed to remain for a given length of time (flies, 24 hr, and moths, 3 to 6 hr) before determining the number killed. In making the counts for dead and live insects, those that were actually dead or were so crippled that they could not fly were counted as killed. From 50 to 75 insects were used for each run.

Results. In Fig. 2 are typical curves for both flies and moths showing the percentage killed at a given voltage with various currents and distances between bars on the grid. Similar curves were obtained for each grid and for several voltages between the minimum at which a reasonable kill could be obtained and the maximum voltage at which the grid could be operated. The percentage of insects killed at a given voltage increased with the current up to a certain value, at which it reached a maximum and remained practically constant regardless of the current.

In Fig. 3 are shown the maximum percentage of insects killed with different voltages and distances between bars on the grid, and a maximum of 30 ma of current. For each given spacing of the grid bars there was a certain voltage above which little advantage was gained while below it the kill decreased quite rapidly. Above a given voltage a greater kill was obtained with moths than with flies.

In Fig. 4 are curves showing the voltage and current necessary to obtain a 75 per cent kill of insects with various spacings of the grid bars. Up to about 15 ma the voltage decreased fairly rapidly with an increase in current. Little was gained in going above 15 ma, and a point was reached where a further reduction in voltage would not give a 75 per cent kill regardless of the current. With sufficient voltage, 75 per cent *(Continued on page 490)*

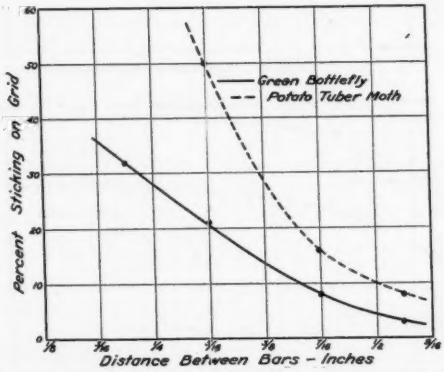


FIG. 5 PERCENTAGE OF INSECTS STICKING TO ELECTROCUTING GRIDS WITH VARIOUS DISTANCES BETWEEN BARS

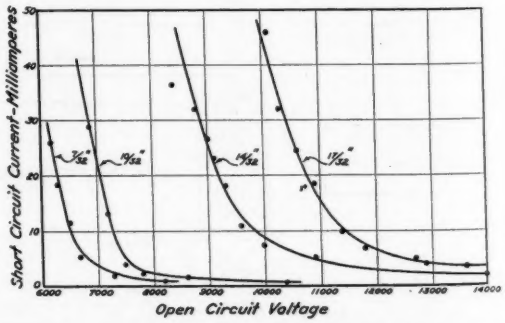


FIG. 6 VOLTAGES AND CURRENTS AT WHICH CONTINUOUS ARCING OCCURS ACROSS AIR GAPS OF ELECTROCUTING GRIDS WITH VARIOUS SPACING BETWEEN BARS

Water-Holding Capacity of Soils and Its Effect on Irrigation Practices

By F. J. Veihmeyer and A. H. Hendrickson

IT IS a well-known fact that coarse-textured soils, the sands, when not waterlogged, usually hold less water than do fine-textured ones, the clays; but it is not so generally known that some sands may hold as much water usable by plants, as do some clays. Of course, the value of a soil depends largely upon how much usable water can be stored in it. Unless the soil can yield the water to plants, its high water-holding capacity is of no advantage. The amount of water that can be stored in the soil for use by plants is the important consideration.

Before proceeding it may be well to clarify the meaning of some of the terms used in connection with soil-moisture conditions. The term "water-holding capacity" has various meanings. Sometimes it is used to indicate the total amount of water in the soil at saturation. At other times it refers to the amount of water the soil will hold shortly after it is wet by rains or irrigation, and has the same meaning as the term "field capacity." We use field capacity (10)[1] to indicate the amount of water held in the soil after the rate of downward movement of water has materially decreased, which usually takes place within two or three days in pervious soils of uniform structure and texture. Field capacity and water-holding capacity in this discussion are used interchangeably and have the same meaning.

It may be interesting to note that the amount of water required to saturate a soil, which, of course, is determined by the total pore space in the soil, does not bear a direct relation to the texture of the soil. It is frequently stated that sands, when saturated, hold less water than clays. This generalization is not justified from the available data (9). There do not seem to be appreciable differences in porosities in soils of the same origin. The porosities of clays may be no greater than those of sands of the same series.

It has been shown that the moisture equivalent is a close measure of the field capacities of fine-textured soils, but not always of sandy soils (10). Unfortunately, however, the moisture equivalent does not have a constant relation to the amount of water which remains in the soil when plants wilt, the "permanent wilting percentage" (11). The moisture equivalent when divided by the factor 1.84 gives the "wilting coefficient," and it has been thought that plants would not wilt so long as the soil-moisture content was above this percentage. The factor 1.84 does not hold for all soils. In fact, the departures from it are so great, as indicated in Table 1, that its use may lead to great inaccuracies.

Table 1 contains the data from a few of the soils tested. The ratio of the moisture equivalent to the permanent wilting percentage may be referred to as the "availability ratio". Wallihan (15) has found a Dunkirk silty clay loam with an availability ratio of 4.56, which is the highest reported up to now in this country. Schofield and Da Costa (5) report a soil with a ratio of 8. Wadsworth and Shaw find that some of the Hawaiian soils have very low ratios, in one case (14) as low as 1.11. Our attempts to calculate the permanent wilting percentage of a soil by multiplying water vapor absorption values, such as that absorbed over distilled water, and various concentrations of sulphuric acid, by various coefficients have not given accurate results. In fact, there appears to be no simpler way than by growing plants on samples of the soil and determining the water remaining in the soil at the time the plants permanently wilt.

The variation in the availability ratios with depth of soil, even at the same spot in a field, is sometimes great. For instance, the ratios varied from 2.16 to 1.63 within a depth of 4 ft of soil in one field and in another, within a depth of 6 ft, they ranged from 2.05 to 1.58.

The permanent wilting percentage is the moisture content below which the plants cannot readily obtain water. It is the soil-moisture condition at which plants wilt and do not recover unless water is applied to the soil. When the soil moisture is reduced close to the permanent wilting percentage, a drooping of the leaves of the plant generally occurs, usually during the late afternoon. It has been found for a wide range of soils that, if this wilted condition persists the following morning, the permanent wilting percentage has been reached in that part of the soil filled by the major portion of the root system. This percentage, then, limits the normal activities of the plant.

The water in the soil cannot all be used by plants because a certain amount is held so tightly by the soil particles as to prevent the roots of the plant from absorbing it rapidly enough to keep them from wilting. The soil moisture is not so readily available below the permanent wilting percentage as above it. Therefore, the moisture above the permanent wilting percentage is referred to as readily available mois-

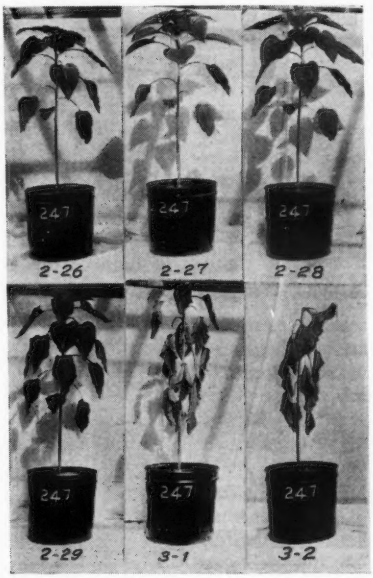


FIG. 1 SUNFLOWER ON SOIL AT DIFFERENT MOISTURE CONTENTS

On February 26 soil was at field capacity, 30 per cent, and at 23, 20, 16, 15, and 14.5 per cent on succeeding days. No evidence of water deficiency could be detected in plant until 16 per cent soil moisture was reached, when slight drooping of lower leaves was evidenced

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Authors: Respectively, irrigation engineer (Mem. A.S.A.E.) and pomologist, University of California.

[1]Numbers in parenthesis in the text indicate references cited at the end of this paper.

ture. Our experiments show that water may be used by plants with equal facility throughout the entire range of soil-moisture contents between the field capacity and the permanent wilting percentage.

The plant shown in Fig. 1 is on a soil at 30 per cent moisture, its field capacity, on February 26. The soil moisture dropped on succeeding days until on February 29, it reached 16 per cent, at which time a very slight drooping of the lower leaves could be detected. The next day, when the moisture was 15 per cent, most of the leaves were drooped and on March 2, when 14.5 per cent was reached, the plant was wilted. No evidence could be detected in this plant and many others tested in a similar manner in small and large containers and in the field, that a deficiency of water occurred until the moisture content was reduced close to the permanent wilting percentage.

Several varieties of grapevines (3), different kinds of deciduous fruit trees (2, 4), and various field crops have been studied to determine the effect of soil-moisture conditions on the growth of the plant, and growth and quality of fruit; but in all cases no significant difference was found until the soil moisture in contact with the roots of the plants was reduced to about the permanent wilting percentage. Typical results are shown in Figs. 2 and 3. The soil-moisture record in two plots in a peach orchard is shown in Fig. 2. One of these marked "wet" was kept at a high moisture content throughout the season. The "dry" plot was allowed to dry out before the peaches ripened. The soil moisture reached the permanent wilting percentage, shown by the horizontal dotted line, for each foot of soil, during the first week in August. Fig. 3 shows the growth of peaches in the plots. The decrease in rate of growth in the dry plot coincided with the time the soil moisture reached the permanent wilting percentage.

Fig. 4 is the soil-moisture record in an unirrigated walnut orchard (13). The abrupt decrease in moisture extraction for each foot of soil is evident. The flattened portions of the extraction curves correspond to the permanent wilting percentages. These results are typical of many tests with different plants, in that they show equal facility for moisture extraction so long as the moisture content is above the permanent wilting percentage, and that the uptake of water by the plant almost ceases when this moisture content is reached. Of course, the differences in depths of rooting of plants determine the depth of soil affected by root extraction.

It is apparent, then, that one of the important soil-moisture conditions is the permanent wilting percentage which limits the growth of plants and which determines the amount of readily available water which can be stored in the soil. Soils which have high water-holding or field capacities may be poor water-yielding soils because of high permanent wilting percentages and consequently narrow ranges of readily available water.

Soils with low availability ratios, even though they may have high field capacities, require much more frequent irrigation than do soils with similar field capacities but with high ratios and large amounts of readily available water. Since waste is unavoidable at each irrigation, due either to evaporation, runoff, or deep percolation, the use of water will be higher with soils having low availability ratios than is the case with soils having similar field capacities but with higher ratios. The amount of water required to irrigate soils with narrow ranges of readily available water and low availability ratios is increased materially, especially when shallow-rooted crops are grown. A case of this kind is described by Edlefsen (1). Similar studies with soils

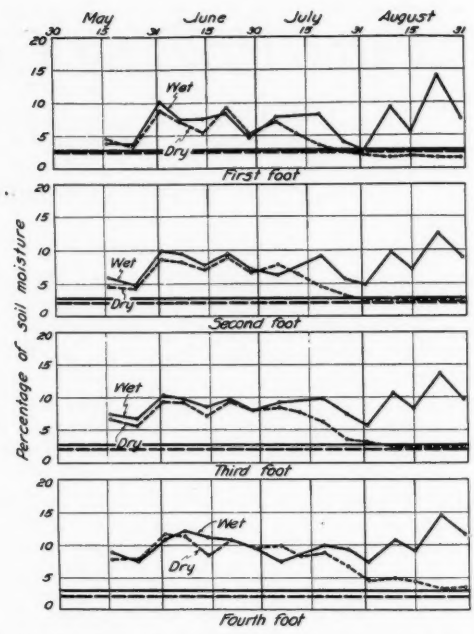

FIG. 2 SOIL MOISTURE CONDITIONS IN A PEACH ORCHARD. THE PERMANENT WILTING PERCENTAGES ARE SHOWN BY THE HEAVY HORIZONTAL LINES, THOSE FOR THE WET PLOT BY SOLID LINES, AND FOR THE DRY PLOT BY BROKEN LINES

having narrow ranges of readily available water have been reported by Wadsworth, Shaw, and coworkers in Hawaii (6, 7, 14).

The loss by surface evaporation may account for a large portion of the increased water requirement under these conditions. It has been shown (8) that, while the losses of moisture by direct evaporation from the soil are confined to a shallow surface layer, this layer dries out very rapidly, and, although such losses are very small compared with the total amount taken from the soil by plant transpiration, when frequent light applications of water are made, these evaporation losses may be an appreciable part of the total amount applied. The actual amount of water required for plant transpiration may be substantially the same, if the leaf area is comparable, whether the plants are grown on soils of high or low water-yielding capacity; but since the soil will dry out to a certain depth by evaporation following each irrigation, those which require infrequent irrigations

TABLE 1. MOISTURE RELATION OF SOME AGRICULTURAL SOILS

Soil	Moisture equivalent	Permanent wilting percentage	Ratio: Moisture equivalent to Permanent wilting percentage "Availability ratio"	Readily available water per foot depth, in
FS	10.50	3.05	3.44	1.24
TL	13.71	4.51	3.04	1.54
25	14.56	3.62	4.02	1.84
J	17.07	6.14	2.77	1.83
Y	17.16	8.82	1.95	1.40
TC	17.30	7.89	2.19	1.58
S	21.35	10.20	2.09	1.87
51	21.70	5.02	4.35	2.80
OL	23.36	6.12	3.82	2.89
OC	24.51	11.55	2.12	2.17
MG	25.63	10.47	2.45	2.54
AC	30.42	16.00	1.90	2.20
P 5-5	31.12	25.70	1.21	0.71
V	37.90	19.03	1.99	3.17

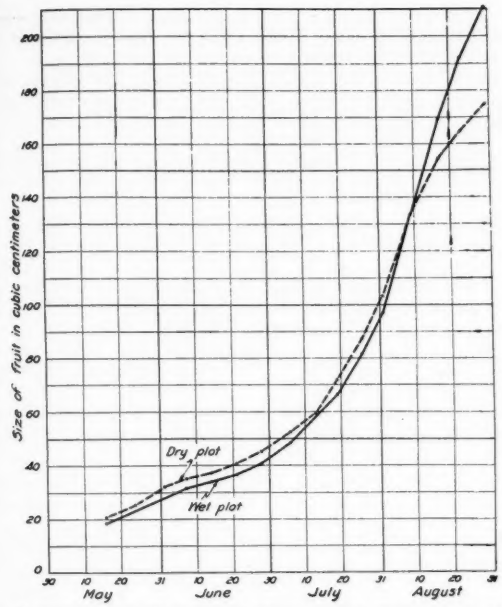

FIG. 3 GROWTH OF PEACHES IN ORCHARD FOR WHICH SOIL MOISTURE RECORD IS GIVEN IN FIG. 2

certainly will lose much less water in this way during the season than soils which need frequent applications.

It is readily apparent then that knowledge of the total amount of water in the soil is of little value to the irrigator unless the permanent wilting percentage is also known. In other words, the amount of readily available water must be determined for each soil in order to plan a rational irrigation schedule.

From the foregoing discussion it may be assumed that the field capacity and the permanent wilting percentage are to be considered constant quantities for a given soil. This statement is not precise, because the permanent wilting percentage as we use it, represents a narrow range of soil moisture within which wilting takes place, and the field capacity cannot be determined exactly. The permanent wilting percentage, however, usually can be measured to within one per cent of soil moisture. It is characteristic of the soil and is independent of the kind of plant or variation of climatic conditions likely to be met with in the field. Neither the permanent wilting percentage nor the field capacity can be changed greatly by application of organic matter or other fertilizers.

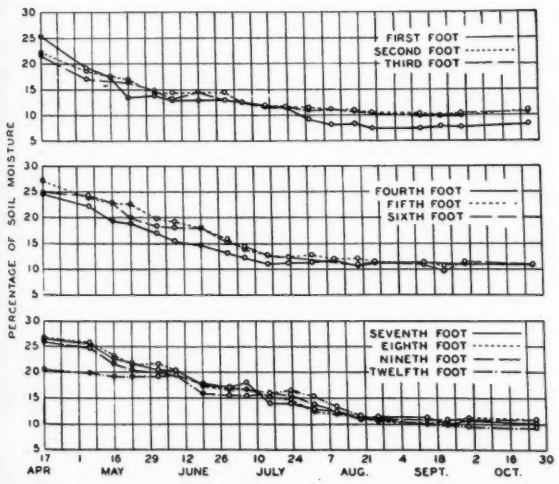

FIG. 4 SOIL MOISTURE CONDITIONS IN A WALNUT ORCHARD TO A DEPTH OF 12 FT. THE ABRUPT DECREASE IN WATER USE WHEN THE PERMANENT WILTING PERCENTAGES ARE REACHED IS INDICATED BY THE FLATTENED PORTION OF THE EXTRACTION CURVES

When water is applied to a dry soil of uniform texture and structure, it is rather quickly distributed and the soil is raised throughout the portion wetted to its field capacity. Subsequent movement is extremely slow in either an upward, downward, or lateral direction. Consequently, soils in place in the field cannot be partially wetted, but must be wholly so or not at all. The belief is still prevalent that certain definite moisture contents between the field capacity and the permanent wilting percentage can be maintained by manipulation of the water or by the use of certain devices designed to secure a uniform and rapid distribution of water. In fact, unless the soil can be removed from the field and dried, and then the water applied by spraying on the soil while constantly turning and mixing it, no moisture content other than the field capacity can be brought about. Of course, soils may be dried by plant root extraction to moisture contents between the field capacity and permanent wilting percentage, but subsequent irrigation will raise them to the field capacity. When water has been allowed to saturate a soil to a water table 30 ft or more below the surface and is then shut off, it may take a long time before the upper 6 ft is drained to field capacity, a process which takes a few days when only the top layers are wet.

Some engineers seem to believe that a definite moisture content can be brought about and maintained in soil in place in the field, as is evidenced by the following quotation from a paper in a recent issue of an engineering journal (16) in which the wetting of soil for use in earth dam construction is described:

"The sprinkler system is installed over a given borrow pit area about 90 days in advance of excavation. First sprinkling consists of putting on as much water over a 48 to 72 hr period, as the ground will absorb. After this initial wetting, the water is turned off, and systematic examination is made by auger holes to determine the moisture content over the area for the required depth which will be excavated. On a basis of this determination, the quantity of water required to bring the average moisture content up to about 11 per cent is calculated, and this is applied by the sprinkler system, with careful control by metering the water supply and observing the time element. With this measured volume of water applied to the borrow pit, it is allowed to stand, and the moisture content to equalize until excavated."

Surely this must be incorrect for soils with moisture equivalents or field capacities which differ from 11 per cent. Soils in place in the field may take an extremely long time to dry out much below their permanent wilting percentage (Fig. 4), except in the shallow surface layer which is affected by direct evaporation. Therefore, soils with permanent wilting percentages higher than 11 per cent will not be found in the borrow pit with moisture contents as low as 11 per cent, and, on the other hand, those with moisture equivalents lower than 11 per cent will remain wetted near this percentage for only a very short time after irrigation unless there is a water table relatively close to the surface.

The following may serve as a brief summary of some of the points discussed: A knowledge of the total amount of water soils will hold shortly after irrigation, the field capacity, must be supplemented by a determination of the residual water in the soil in contact with the roots of plants

at the time the plants permanently wilt, the permanent wilting percentage.

An approximately correct statement is that the permanent wilting percentage is the lower limit of available water. Soils, below the shallow surface layer which may be dried by direct evaporation, seldom dry out much below this moisture content. The water between the field capacity and the permanent wilting percentage is readily available to plants, and in our experiments no evidence of water shortage has been detected until the moisture content of the soil is reduced close to the permanent wilting percentage.

The field capacity and the permanent wilting percentage may be considered as characteristic of the soil and cannot be changed appreciably by the addition of organic matter or other fertilizers.

High field capacity may cause a soil to be considered a good one, from a moisture viewpoint, but actually it may be a poor soil because of a high permanent wilting percentage and small amount of readily available water. Soils with narrow ranges of readily available water may require frequent irrigations especially with shallow-rooted crops and consequently the waste involved in irrigating may materially increase the use of water.

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Energy Requirements and Safety Features of Electric Insect Traps

(Continued from page 486)

kills were obtained with less than 5 ma. It requires approximately 250 to 500 volts for each 1/32-in spacing between grid bars to obtain a 75 per cent kill. The lower value is approached with smaller spacings and higher currents and the larger values with wider spacings and lower currents.

In conducting the experiments, difficulty was encountered with insects sticking on the grid. This difficulty was independent of the current and voltage, but was dependent on the space between the bars and the type of insect, as shown in Fig. 5. At the higher voltages and currents, when heavy arcing occurred, the trap had a tendency to clean itself, while at the lower voltages and currents it was necessary to clean the trap by hand.

In Fig. 6 are shown the voltages and currents at which the air gap between bars broke down and continuous arcing occurred. As the current was decreased, the voltage required to break down the air gap increased. While these voltages given are the absolute limit that could be used on the grids, the practical limit would be only about 75 per cent or less, as once the gap is broken down, arcing will continue at lower voltages. Some trouble was experienced at the higher voltages and currents used in the test with arcing continuing after the insect had started it.

Remarks. From the experiments conducted with the green-bottle fly and the potato tuber moth, there is a definite range of current depending upon the voltage and space between bars that will give a satisfactory kill of insects on an electrocuting grid. Because satisfactory kills were obtained with very small currents (less than 5 ma) and because of the similarity of the current-voltage curves for a 75 per cent kill (Fig. 4) and for breakdown of the air gap between bars (Fig. 6), there is an indication that the current and voltage are governed by that necessary to create an arc rather than that necessary to kill the insect.

In the practical use of electrocuting grids on insect traps, other factors besides killing the insects must be considered in determining the electrical requirements. The use of high voltage makes insulating more difficult and increases corona loss. In the laboratory the latter was both audible and visible in a dark room from the loose ends of the bars when the voltage exceeded about 5000 volts.

The use of neon lights (which is common where colored light is desirable) presents a problem in reducing the current. On traps where an ordinary mazda light is used to attract insects, the current and voltage on the grid are independent of the light. When neon lights are used, however, the light is operated in parallel with the grid from the high-tension transformer and the current in the light is the same as in the grid. Since the intensity of the light is an important factor in attracting the insects, reducing the current on the grid would also reduce the light intensity and cut down the number of insects which would be attracted.

Since it is essential that the grid be kept clear of dead insects, sufficient current and voltage should be available to burn or knock them off by arcing in case they stick on the grid.

Before definite conclusions can be drawn, further experiments should be conducted with a very small insect such as the grape leafhopper, which has a wing spread of less than 1/8 in and some other insects such as hard-shelled beetles and large moths.

Agricultural Engineering Research — A Cooperative Activity

By Ben D. Moses

AGRICULTURAL engineering is not fundamentally agricultural, but its usefulness lies in the application of engineering principles to the farm and farm home. The head of one agricultural engineering department, in presenting the work of his staff to the college faculty, said: "The agricultural engineer cannot be independent. His problems are the engineering phases of your problems; there's where he will have his work, or he won't have any." Seldom does the agricultural engineer encounter a research problem limited to his own field; he must work either directly or indirectly in cooperation with scientists in other branches of agricultural science.

The useful agricultural engineer recognizes that he could make no progress in the precooling of fruit, for example, without the pomologist's knowledge of fruit and its behavior under different conditions. He knows that he is incompetent to compare chicks hatched in an incubator with those under a hen; that a bacteriologist's analysis of milk handled in a new way is essential; that a horticulturist would be the best judge of the development of a shrub under soil-heating treatment; that the technique of an entomologist is essential to the success of an experiment in combating certain insect pests.

Recognizing this state of mutual dependence, agricultural engineering departments of the land-grant colleges and universities have invited the counsel and active help of other departments in the solution of certain problems. As a result, mutual confidence has been established in many instances, and there is now a liberal interchange of ideas among the different departments.

FUNDAMENTALS OF COOPERATIVE RESEARCH

Several years ago H. B. Walker, of the University of California, wrote as follows (AGRICULTURAL ENGINEERING, November 1927, page 305): "In any cooperative enterprise three fundamental requirements are necessary for success: (1) There must be a mutual problem; (2) the problem must be more easily solved by joint action; (3) there must be mutual confidence among the cooperating agencies."

It might be added that the success of a cooperative project is proportional to (1) the interest of the cooperator, (2) his availability for conferences and for working, and (3) his personal fitness in the form of technical and practical training.

The best way for the engineer to establish confidence is to be ready to work and willing to share honors. He must generously recognize, both in attitude and in publications, the contributions of others. Credit must be given where credit is due, and we must be humble in our personal claims. Sincere mutual recognition produces harmony and gets results. It is a false step for the agricultural engineer to pass judgment upon results outside of his field, just as the pomologist, truck crops specialist, or agronomist would err in discussing the operating characteristics of an electric motor or centrifugal pump. The objective of all cooperating parties must be the solution of agricultural problems, and the publication of findings.

Because personal advancement is sometimes believed to depend upon individual accomplishment, the scientist is often a rather secretive worker. Some investigators would rather "paddle their own canoes"; they had better stick to the individual type of research. Even the individualist, however, will frequently find that cooperation with another scientist in a different field will develop his own stock of knowledge and render him more efficient. Certain scientists avoid "teaming up" because they are apprehensive of losing, through some breach of confidence or misunderstanding, the fruits of their investigations.

PERSONAL FACTORS IN COOPERATIVE RESEARCH

Cooperation is most readily established between those of different training, where each recognizes the other as an authority in his own field. It is not so easy to establish cooperation between men of parallel fields.

The head of one department is responsible for this statement: "The individualist investigator tends to become a specialist, and the more he specializes the more he has to confer with other specialists." In commenting upon seeming failures in attempts to cooperate, he says: "This failure is evidence that either the men are not big enough or that the subject matter is too closely parallel."

It is very easy for a specialist to underestimate the value of another's training, and conceit on the part of either cooperator works against harmonious action. Sometimes petty jealousies arise because one of the men does not correctly understand the problem and is fearful that his superficial knowledge will be exposed by the better-trained scientist.

The reasoning useful in one field cannot always be extended to another, and a thorough knowledge of all the factors is essential to success. Just because the exposure of diseased rats to a certain light showing an ultra-violet band may have a beneficial effect, one cannot infer that laying hens should be irradiated; nor does the ultra-violet constituent of the light from that lamp necessarily account for all the results obtained with the rats. Such items as rickets in chickens, milk production from cows, vitamin content of eggs, productivity of plants, and color of flowers, are too highly technical to be approached by the engineer except through cooperation with specialists in these fields. The results looked for concern the physiology of plants and animals, their diseases and general habits, and are more closely related to the biological than to the physical sciences.

Each specialist should be confined to his own field and must contribute toward the large general objective in such a way that the results are given in specific rather than general terms. For example, it is more satisfactory to be able to say, "When hens are irradiated with light of wave length a and intensity b for h hours per day, eggs will be produced that contain x units of vitamin D", than simply to state

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Presented before the Committee on Research round table at the annual meeting of the American Society of Agricultural Engineers, at Asilomar, Pacific Grove, Calif., June 27, 1938.

Author: Associate professor of agricultural engineering and associate agricultural engineer in the experiment station, University of California. Mem. A.S.A.E.

that hens irradiated with ultra-violet light produce eggs rich in vitamin D.

The agricultural engineer should not be discouraged by the complex relationships involved in such a project, but should accept the challenge and do his best to cover the field completely and to make the work so cooperative that authorities will not question the results.

Several years ago electric brooding was considered impractical because of the high heating cost. Brooders using other types of artificial heat were proving successful, but when the manufacturer attempted to replace these heating appliances with electricity, the cost was too high or the ventilation too poor. In an effort to gather information for the manufacturer and the brooder operator, the California experiment station inaugurated a cooperative project between the divisions of agricultural engineering and poultry husbandry to determine the effect of various quantities of air, of carbon dioxide and oxygen concentration, and of per cent humidity upon the health and growth of baby chicks. The project was divided into two parts: (1) the design, construction, and equipment of experimental brooders, and (2) physical and biological observation upon the chicks and upon the physical conditions under which they lived. Each cooperator assumed his individual responsibility, and after four years of observation we have been able to draw definite conclusions, as follows: (1) Given the conditions under which the experiment was conducted, less than 2 cu ft of air per 100 chicks per minute is insufficient; (2) more than 4 cu ft of air per hundred chicks per minute is not needed; (3) so long as there is sufficient ventilation to maintain a dry hover, neither carbon dioxide nor oxygen concentration enters into the problem, and (4) the operator can use the dryness of the litter and the general condition of the baby chicks as a correct indicator of ventilation under the hover.

An important outcome of this project has been its continuation by the animal husbandry division from a purely scientific approach. A highly trained specialist in animal nutrition has completed a series of tests checking the metabolism in baby chicks under controlled conditions of humidity, temperature, and carbon dioxide and oxygen concentrations.

To sum up, although the first objective was to obtain information on the amount of air that should be supplied to a brooder, and although there were only two workers involved, other important phases have since been brought to light and other cooperators attracted to the project. It is impossible to evaluate directly the benefits thus brought to the poultrymen, the manufacturer, and the subject-matter divisions. Valuable contacts are made and relationships established through harmonious cooperation on a project of this sort when carried through to a satisfactory conclusion.

DEGREES OF COOPERATION VARY WITH THE PROBLEM

There are different degrees as well as different methods of cooperation in research. Whether it be in the form of supplying helpful information, of suggesting ways of carrying on the investigation, of assisting with the finances, of furnishing equipment, instruments, supplies, or of editing manuscripts, it is a fact that cooperation expedites the work, hastens the publication of material, and establishes confidence in the conclusions.

In general, an individual forms the nucleus about which research work is woven. He should be a specialist, and the problem his hobby. He is practically indispensable, and yet he must look to others for support. What, for example, would unlimited funds and equipment have availed the General Electric Company without its Steinmetz? On the other hand, how handicapped he would have been without the company's support in money, apparatus, and personnel!

One of our California experiment station cooperative projects illustrates this point quite clearly. The question "What effect does current interruption have upon the operation of an electric incubator?" came to the attention of the agricultural engineering division and was referred to poultry husbandry for information. Dr. W. L. Taylor of that division offered his cooperation in making some tests. He had at his disposal a flock of hens with ancestry of known characteristics for several generations back; he had also a flock of full brothers with similar pedigree data. He was assisted by men familiar with the handling and marketing of eggs from trap nest to the end of incubation, by technicians trained to keep records and to make computations, and by an embryologist who helped him in analyzing the eggs that failed to hatch. He is himself a highly trained embryologist and geneticist, in an environment of university poultry scientists where he can apply his knowledge and skill. But our assistance was needed to bring the problem before the California Committee on the Relation of Electricity to Agriculture, to obtain a budget and make it available to Dr. Taylor, and to help him in his layout of incubators by setting up his equipment, metering the current, and contacting the power company so as to insure good voltage regulation and continuous service. Such a setup is quite difficult of duplication, but essential to an accurate investigation, and produces highly authoritative results.

PUBLIC INTERESTS FAVORING RESEARCH COOPERATION

Some projects are necessarily of a cooperative nature because they affect public health or come under legal regulation. These deal with sterilization, pasteurization, food processing, handling of poisonous sprays, and the like.

Suppose, for example, that the project to be worked upon has for its object the pasteurization of milk by passing an electric current through it. The engineer can design a vessel fitted with the proper electrodes; but first he would like to know (1) what are the physical properties of the milk, (2) what should be the characteristics of the electric energy, and (3) what are the limiting factors, in heat developed and in duration of exposure? He turns to specialists in the dairy industry department. They may not be able to satisfy his demands, but, using the information at hand, he builds the apparatus. It does the work so far as he can judge, but he finds that there must be (1) careful counts of the bacteria present before and after treatment, (2) tests for physical properties such as cream line, taste, odor, and appearance, and (3) studies to determine the effect upon pathogenic organisms. He recognizes at once that the success of his work depends upon cooperation from bacteriologists, chemists, milk specialists, and health authorities with their laboratories, guinea pigs, and technicians.

The prime requisite, then, of a research agricultural engineer seems to be that of a cooperator, bringing together the industrial experimenter, the technical investigator, and the producer; assisting in the organization and working out of the projects; and placing the material where it can be available to all interested in the results.

He may be termed a transformer, stepping down the technical findings to practical applications, or stepping up the practical demand for information into a highly specialized fundamental project; an exciter, energizing the field of the investigator; a synchronizer, putting in step various endeavors or correlating data; a motor, driving machinery within his own field; an accumulator, storing information for future use; and, though he should be a broadcaster, he should never be a loud speaker!

Progress of Farm Electrification in the Tennessee Valley

By C. J. Hurd

RURAL electrification is primarily an agricultural problem. As such it affects not only the lives and habits of farm people, but exerts a powerful influence both directly and indirectly on farming operations.

In regions such as the Tennessee Valley, where farmers are faced with the necessity of major agricultural adjustments, electricity has even greater significance. Agricultural engineers have been given the task of applying their skill in suggesting ways in which electricity can aid in making these agricultural adjustments an economic and sociological reality. This, briefly stated, is the rural electrification program of the land-grant colleges in the Tennessee Valley and the agricultural engineering development division of the Tennessee Valley Authority.

AGRICULTURAL BACKGROUND

To give a picture of the scope of this problem requires, first, a brief summary of the agricultural situation of the Valley. Within the drainage area of the Tennessee River and its tributaries there are approximately 28,381,000 acres, of which 17,800,000 acres are farm land. In this area approximately 1,150,000 farm people reside on 250,000 farms. The average size of the farms is 70 acres, with only about half, or 35 acres, now in crop and pasture land. The balance is in woodland or untillable soil.

Cropping systems and farming practices, combined with an annual rainfall exceeding 50 in, have resulted in over 6,000,000 acres or nearly 30 per cent of the farming area being badly eroded. This erosion problem has been aggravated due to a practice of many years of growing cultivated crops, such as cotton, corn, and tobacco on hillside slopes.

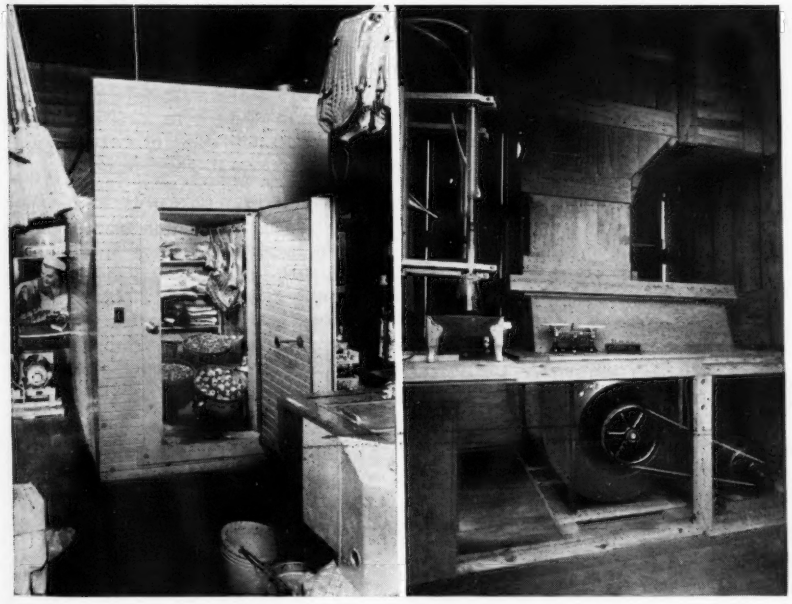
Farmers, observing the continued depletion of their upland soils by erosion and the destruction of fertile bottom lands by floods, are cooperating to the fullest extent by forming soil conservation associations to foster a program to check the ravages of water on their lands. The land-grant colleges of the seven valley states are conducting experiments and demonstrations on thousands of farms to determine the value, effect, and best methods for the use of phosphatic fertilizer in a rational farm management system, by which soil erosion may be reduced and soil fertility restored and permanently maintained. These phosphatic fertilizers are a product of the experimental plant at Muscle Shoals.

The farmer, however, can follow these farm management practices only as he can be reasonably sure of a farm income sufficient to offset the primary investments for terracing, legume seed, fertilizer, and new farm implements. On many farms it means new agricultural enterprises must be started to bring additional net farm income.

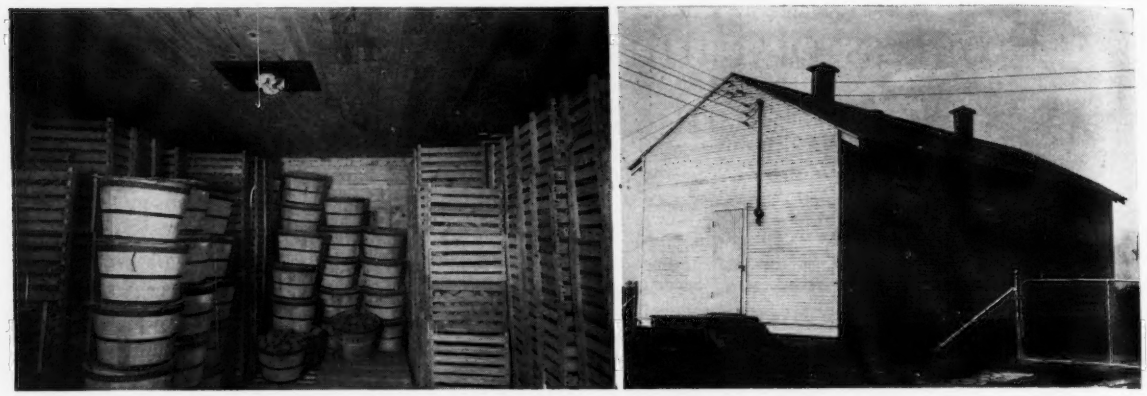
The part that rural electrification has to play is quite definite. Electricity makes possible certain economies in farming operations: (1) It enables farmers to branch into new agricultural enterprises, (2) it makes possible certain types of intensive farming on bottom lands so that the upland can be devoted to soil-building crops, (3) it promotes better quality products which will return higher net farm incomes, and (4) it brings about better living condi-

Presented before the Rural Electric Division at the annual meeting of the A.S.A.E., at Asilomar, Pacific Grove, Calif., June 29, 1938.

Author: Acting chief, agricultural engineering development division, department of agricultural industries, Tennessee Valley Authority. Mem. A.S.A.E.



(EXTREME LEFT) COMMUNITY WALK-IN REFRIGERATOR AT KENSINGTON, GA. (LEFT) INTERIOR OF BLOWER ROOM IN HAY DRYING SYSTEM ON ALEX LOCKER'S FARM NEAR FLORENCE, ALA. GLASSWARE, HOT PLATES, AND BALANCES IN LEFT FOREGROUND ARE FOR MOISTURE DETERMINATION. AIR FLOW IS REVERSIBLE BY REMOVING THE SHORT SECTION OF HORIZONTAL CONDUIT AND SLIDING ELBOW SECTION TO THE RIGHT



(LEFT) INTERIOR OF 600-BU SWEET POTATO CURING HOUSE HEATED BY ELECTRICITY THROUGH SOIL-HEATING CABLE UNDER A FALSE FLOOR. (RIGHT) EXTERIOR OF ALL-ELECTRIC 2000-BU SWEET POTATO CURING AND STORAGE HOUSE, MARTIN, TENN.

tions which are essential in keeping the new generation of young farm men and women interested in agriculture.

AGRICULTURAL ENGINEERING PROGRAM

The agricultural engineer is faced with the responsibility of making an effective contribution to the solution of these related problems. He must see that a proper balance is kept in making possible these advantages of rural electrification. For example, over-emphasis on electrical comforts and conveniences only means that the farm is saddled with additional debts and expenses. Also, the promotion of new agricultural enterprises, without regard to a market, may cause farm failures. The agricultural engineer must work closely with the various agricultural specialists in the adaptation of electricity to southern agriculture. Following successful development, these applications are introduced to the farmer entirely through existing agricultural educational agencies.

Such a rural electrification program is being followed in the Tennessee Valley. The Tennessee Valley Authority has contracts with the agricultural extension services of Alabama, Tennessee, Georgia, and Mississippi to provide partial support of rural electrification specialists on their staffs. In this way the program on rural electrification education is coordinated with other agricultural subject-matter specialists. It also is a matter of economy, since existing facilities and supervision need not be duplicated.

The contribution of the agricultural engineering development division of the Tennessee Valley Authority has been to supply a small staff of agricultural engineers to assist the existing agricultural research and educational agencies. During the past year this staff included five men on farm machinery research and investigation, five men on farm electrical research, and two men and two women on rural-electrification education.

FARM MACHINERY DEVELOPMENTS

Farm machinery research, although having little direct application for electricity, is important to enable farmers to have proper farm equipment to economically carry on soil conservation practices. This work is conducted cooperatively with the agricultural experiment stations and deals largely with investigation and development of inexpensive equipment for seeding, harvesting and threshing small grains and legumes, and distributing lime and fertilizers. Since the low income farmers are in the majority and therefore must do most of the job of caring for the land, these developments are centered around the requirements of the small farmer.

An example of the development on farm machinery is a hillside seed and fertilizer distributor[1] that can be pulled with an ordinary farm team. This equipment enables the small farmer to follow a practice of seeding fall grain on legume or grass sod, thus making possible year round protection of the soil. The seeder cuts narrow furrows about 18 in apart and deposits in one operation grain and the proper amount of phosphate fertilizer, without disturbing the matted root system between the furrows. These furrows are made on the contour of the ground, which aids materially in checking rapid water runoff.

This machine has been given practical farm tests on over 1500 acres of hillside land, with farmers reporting grain yields equal and up to 25 per cent higher than with conventional seeding methods. It will soon be placed on the market by a farm machinery manufacturer, selling for about $25. This machine fills a real need, since it is within the price range that the small hillside farmer can afford and enables him to follow a soil conservation practice that will bring him cash returns.

FARM ELECTRICAL RESEARCH

Farm electrical research is devoted almost entirely to income-producing or labor-saving equipment. Here again the developments are carried on cooperatively with the existing agricultural agencies. These research men have two major functions. One task is to secure sufficient data on present farm electrical equipment to determine its economic and mechanical feasibility for southern farms, and, if necessary, make certain changes to adapt it to local conditions. The second task is to develop new uses for electricity that will make additional contributions to farm income.

COMMUNITY REFRIGERATION

Farm refrigeration is a good illustration of adapting a known development to the needs of a region. In the South nearly one-fourth of the pork being cured is lost due to a lack of proper cooling and curing facilities. Also, lack of farm refrigeration has been another reason for the unbalanced diet, including the small amount of fresh meat consumed by rural people. Tennessee farm people eat less than 5 lb of fresh beef per capita a year, compared with 44 lb in Ohio. Livestock production just for home consumption at once suggests an economical method for diverting a considerable amount of hill land into pastures. However, the stumbling block is the simple fact that most farmers in the South cannot afford individual refrigerators capable of storing carcasses of beef and pork.

[1]Publication No. 214, Small grain in contour furrows on lespedeza sod. Agricultural Extension Service, University of Tennessee.

A partial solution of this problem has been centrally located meat-curing plants. There are now over 175 large meat-curing plants in the South, each having refrigerating capacities of from ten to twenty tons.

Another method now under investigation and demonstration is rural community refrigeration. Small walk-in refrigerators, having 200 to 250 cu ft net storage space, powered by ¾ to 1-hp refrigeration units, are located at the crossroads store or at a convenient farm. From 10 to 15 farm families jointly own and operate the unit. The cash investment per farm family is $50 to $75, with operating expenses not over 50 cents per month per family. One community during 1937 reports that they cooled and stored 17,551 pounds of meat and other products. In addition to the 12 members, 81 other farm families used the refrigerator during the year. Storage rentals from the nonmembers more than paid the year's electric bill.

The engineering experiment station of the University of Tennessee and the Tennessee Valley Authority jointly developed a unit suitable to these conditions. The University of Tennessee has issued a bulletin[2] showing how to build these community refrigerators. Refrigeration manufacturers have cooperated by offering both knock-down and assembled refrigerators. Thus an adaptation of a well-known electrical application is being made to meet a farmer's problem.

OTHER STUDIES

In a similar way other farm electrical equipment is being studied and adapted to this region. Much of the equipment now in general use throughout the country, such as electric hotbeds, brooders, and dairy equipment, needs only to be observed on farms to secure operating records. Irrigation on the individual farm is being studied carefully from an economic standpoint. Insect trap studies are being made by experiment station entomologists.

The other major function of the research men is to develop new farm uses for electricity. Two projects now under way appear to be promising. Electrically heated sweet-potato curing and storage houses, operated for an entire season, using 1 to 1.5 kwh per bushel, and producing a higher repack and uniform quality, offer distinct possibilities. Barn curing of hay, using only forced-air circulation, is producing hay one grade superior to field-cured hay and, with alfalfa retaining approximately 10 per cent more leaves. This type of drier operates with a power consumption of 50 to 75 kwh per ton of dry hay.

As these and similar research developments reach practical solution, the results will be available for general use throughout the country. Much of the data should be of help to other research workers and educational agencies.

The entire rural electrification program of the TVA agricultural engineering division is directed towards the everyday farm electric problems of the whole region as they relate to correlated development in soil and water conservation. The research and educational activities are planned to help farmers and are carried on without regard to the electric distribution agency serving the farms.

PRACTICAL USES ON SOUTHERN FARMS

It is interesting to observe how the southern farmers of just ordinary means are using electric equipment to make electricity "pay its way" and increase farm incomes.

In North Georgia, Mr. J. S. Christian, a dairy farmer with some 25 cows, without electricity made a net farm income in 1936 of $975. When he first received electric service his primary investment for wiring, lighting, and home conveniences was $342. Electricity made it possible to install refrigeration and other equipment to enter the Grade A bottled milk business. Farm electric equipment cost $927; a truck and other supplies, $1,075. This made a total of $2,344 invested in farm and home improvements. However, his net income for 1937 was $2,364, or an increase of $1,389 over 1936. This represents a return of nearly 60 per cent on his total investment in farm and home improvements.

A neighboring farmer, Mr. Henry Calloway, a truck grower, installed insect traps on three acres of tomatoes. The lighted patch yielded over 90 per cent worm free tomatoes. The crop on the balance of his 15 acres was almost a complete failure due to an infection of corn ear worms.

Electric sweet-potato curing and storage have proven a profitable investment for Mr. G. C. Harris of Ranger, Georgia. Mr. Harris has a 600-bu house and sold all his crop at 15 cents per bushel higher than the "going price," and he had enough calls to have doubled the sales.

Mr. D. M. Babbs of Corinth, Mississippi, reports that he installed a 6x48-ft electric hotbed and seeded it to tomatoes in one day. His former method of preparing manure-heated beds required two full days of labor and five tons of fertilizer. In addition to less net cost by using electricity, he produced 30 per cent more plants with the same size bed.

Truck growers in Mississippi and Tennessee have installed over 300 sash (equivalent to 6 by 900 ft) of electric hotbeds in the past two years.

Yard lighting does not directly affect farm income, yet it speeds up night chores and offers considerable protection against night prowlers. In one county in Tennessee the agricultural extension service put on a few demonstrations of proper yard lighting, and in less than a year more than 50 farmers installed similar outdoor lighting systems.

To promote increased sanitation and lessen drudgery on farms, the Tennessee extension service last year had a state-wide educational program on water systems. Seven types of water systems were demonstrated with discussions led by the extension agricultural engineer. At the end of the year the county agents reported that a total of 3,387 new water systems had been installed, with over 1,500 being automatic electric pumps.

The Tennessee extension service in 1936 and 1937 put on an educational program on all types of chick brooding. In one county, where no electric brooders were in use in 1936, the county agent reported that 48 farmers used a total of 50 electric brooders during the 1938 season.

OTHER COOPERATING AGENCIES

Smith-Hughes instructors and 4-H Club leaders are also contributing to rural electrification education. Smith-Hughes instructors in Georgia, Alabama, and Mississippi have conducted shop projects on the construction of community walk-in coolers. Following the construction they assisted the rural group in the land-use program associated with the utilization of the refrigerators.

I have mentioned briefly only a few of the practical uses being made of electricity on southern farms. I have also just touched on the research and educational activities of the existing agencies.

To make a lasting contribution to agriculture is the goal of the agricultural engineer. The part he has in rural electrification is to assist the farmer in making electricity an efficient tool with which to increase farm incomes, improve farming methods, and provide better living for the farm family. The farm is the mirror that will reflect the degree of progress of his efforts.

[2]University of Tennessee Engineering Experiment Station Bulletin No. 12, "Farm and Community Refrigeration."

What Agricultural Engineers Are Doing

FROM THE U. S. BUREAU OF AGRICULTURAL ENGINEERING

IN STUDYING harvesting operations in the production of sweet potatoes for starch at Laurel, Miss., J. W. Randolph finds that the various methods used differ materially as to the quantity harvested per day, the field losses, and rotting which results from mechanical injury. In addition to determining the most advantageous methods of harvesting, there is apparently need for the development of a systematic procedure in harvesting and delivering sweet potatoes throughout the entire area served by a starch plant.

* * *

E. D. Gordon left Auburn, Ala., on September 29 to make a preliminary study of the problems involved in the mechanical windrowing and harvesting of sugarcane in Louisiana. Mr. Gordon has inspected several experimental harvesters and has conferred with various men connected with sugarcane production. The immediate objective is to study the various factors involved in harvesting sugarcane which will serve as a basis for outlining a definite research program on harvesting equipment.

* * *

After making several improvements on an experimental sugar beet harvester, tests were again made with the machine on three different soil types, ranging from a heavy sediment to peat, in the Davis, Calif. area. The work of the machine, particularly its ability to pick up the beets out of the row and to go through weedy patches without clogging up, was considerably improved. Under favorable conditions over 98 per cent of the beets were lifted from the rows. Because of the variability of beets and tops, the topping job was somewhat less effective, as only 90 to 95 per cent of the beets were acceptably topped.

* * *

In connection with preliminary work on the cooperative study of irrigation in relation to soil erosion, M. R. Lewis reports that in an irrigation demonstration field, in spite of almost continuous irrigation in "down-slope" furrows, the average moisture content of the upper two feet of soil in a potato field had gradually dropped since mid-July. On the other hand, the same quantity of water applied to contour furrows during slightly less time had maintained the soil moisture, because of less surface waste. Mr. Lewis reported also that he found an apple orchard with a grass and alfalfa cover crop irrigated with small furrows directly down the slope, where very little erosion was evident on slopes up to 48 per cent. On the other hand, an orchard with only annual weeds showed serious erosion on a 12 per cent slope. The first was supplied from underground pipe and well-controlled outlets, the other from open earth ditch with poor control.

* * *

Harry G. Nickle, upon request of the chairman of the Texas Board of Water Engineers, was present during the first four days of the hearing of the State Senate Investigating Committee on the floods of the Colorado River of Texas in July and August. Mr. Nickle's attendance was desired in case some question should arise regarding silt, which subject he has been studying for the past several years. Prior to the hearing, Mr. Nickle had assisted the Board in preparing discharge data and hydrographs pertaining to the flood for three sampling stations on the Colorado River and in calculating silt percentages, silt load per second, and total silt at these stations during the recent flood, and also during the 1936 flood.

* * *

Under the leadership of Paul A. Ewing and Harry F. Blaney, work has begun on the survey of agricultural conditions in San Fernando Valley, Calif. Plans for the survey were decided upon in cooperation with the Los Angeles Bureau of Water Works and Supply and the Los Angeles County Farm Bureau. Mr. Ewing and D. W. Bloodgood made a trip through the valley, interviewing cooperators and inspecting agricultural areas. A tract of 32 acres just below the Lower San Fernando reservoir has been set aside by the Los Angeles Water Department for use by the division of irrigation for experimental purposes, and asparagus plants formerly grown on the tract are being eradicated. Fences and concrete pipe lines will be constructed and the land will be leveled. At the Upper San Fernando reservoir, a concrete pipe line has been installed and other structures will be started soon. About 25 acres of rich land has been set aside for experimental studies at this location, and more land is available if necessary.

* * *

J. C. Marr prepared text material for a Snow Cover Survey Manual. R. L. Parshall located several new snow courses, relocated others, and inspected about 25 courses in Colorado. R. A. Work inspected, cleared, and marked snow courses in the Umatilla, Wallowa, and Whitman National Forests. Following a conference held at Baker, Ore., attended by representatives of the principal agencies cooperating in the snow survey work, three additional snow courses were located on the Grande Ronde, Powder, and Burnt River watersheds. Paul A. Ewing, in conference with the Western Radio Program Director for the U. S. Department of Agriculture and officials of the National Broadcasting Company, made plans for initiating programs of winter sports information beginning December 16 and terminating April 29, 1939.

* * *

J. T. Olsen left Washington, D. C., September 17 to supervise a WPA Project in connection with the Mississippi State Planning Commission. He will investigate the present physical and financial status of the drainage districts in the state and make recommendations for their improvement. Mr. Olsen's headquarters are at Greenwood, Mississippi. Lewis A. Jones spent two weeks, beginning September 26, with Mr. Olsen in organizing the work.

* * *

R. L. Parshall made an examination of the Sheep Creek ditch of the Pathfinder Irrigation District, Nebraska, to determine the possibilities of installing a riffle-deflector, vortex-tube sand trap in this channel. As it had been necessary to clean the canal with a drag line twice this season, the manager was anxious to take steps to improve its present condition. A 100-lb sample of the very fine sand carried in the ditch was obtained by Mr. Parshall and tested at the Bellvue, Colorado, laboratory, where it was found that under different velocities, the range of recovery by means of the sand trap was from 35 to 65 per cent. Mr. Parshall is preparing a suggested design of a riffle-deflector sand trap for this channel, based on his experience with the model now in operation at the Bellvue laboratory, and it is hoped this structure will trap about half the sand in the water. Plans were also prepared for a 15-ft reinforced concrete Parshall measuring flume for the inlet channel to Lake Alice, in the Pathfinder District. The capacity of this flume will be 1,000 sec-ft. *(Continued on page 504)*

* * *

Contributions Invited

All public service agencies (federal and state) dealing with agricultural engineering research and extension, are invited to contribute information on new developments in the field for publication under the above heading. It is desired that this feature shall give, from month to month, a concise yet complete picture of what agricultural engineers in the various public institutions are doing to advance this branch of applied science.—EDITOR.

Authors

J. B. Brooks is the writer of "ELECTRICALLY OPERATED WATER SYSTEMS FOR FARMS," University of Kentucky Extension Circular No. 319.

Arnold M. Davis is author of "EROSION ON ROADS AND ADJACENT LANDS," published as Leaflet No. 164 of the U. S. Department of Agriculture.

L. G. Keeney is author of a "FIELD MANUAL FOR INSPECTION AND APPRAISAL OF FARM INSURANCE RISKS", recently published by the Farmers Mutual Reinsurance Association.

M. A. R. Kelley is joint author with H. H. Mitchell of "Energy Requirements of Swine and Estimates of Heat Production and Gaseous Exchange for Use in Planning the Ventilation of Hog Houses," a paper published in and reprinted from the "Journal of Agricultural Research" for June 1938.

James B. Kelley and *Earl G. Welch* have collaborated as authors of University of Kentucky Extension Circular No. 315, "HOW TO ESTIMATE THE COST OF WIRING, EQUIPMENT, AND ELECTRIC SERVICE FOR THE FARMSTEAD." Mr. Kelley is also one of the authors of "BROODING CHICKS ARTIFICIALLY," the fifth revision of No. 157 in the same series. Mr. Welch and *John L. McKitrick* have written "EARTH DAMS FOR FARM RESERVOIRS," No. 317 in the same series.

G. E. P. Smith has written about "THE PHYSIOGRAPHY OF ARIZONA VALLEYS AND THE OCCURRENCE OF GROUNDWATER," in University of Arizona Technical Bulletin No. 77.

NEWS

A.S.A.E. Fall Meeting Program Announced

A WEEK of intensive interchange of information and ideas on agricultural engineering progress is indicated by the program for the Fall Meeting of the A.S.A.E. to be held at the Stevens Hotel, in Chicago, November 28 to December 2. Advance copies of the program are now in distribution and may be obtained on request to the A.S.A.E., St. Joseph, Mich.

Monday, November 28, will be devoted to meetings of the Council, Jury of Awards, and other committees and groups as desired.

The Farm Structures and Power and Machinery Divisions will offer two concurrent programs on Tuesday and Wednesday, November 29 and 30. Thursday and Friday, December 1 and 2, the Rural Electric and Soil and Water Conservation Divisions will hold forth. Evenings are left open for committee meetings and roundtables by arrangement, and for individual contacts and activities.

One evening feature will be the showing of "Steel—Man's Servant," which is said to be the first industrial moving picture produced with both technicolor and sound. The technicolor is particularly effective in numerous shots of hot steel.

FARM STRUCTURES

"Problems in the Farm Storage of Small Grains and Corn" will be the subject of a symposium opening the farm structures program. Contributions listed include "Predicting Moisture Content of Ear Corn from Weather Data," by W. R. Swanson and H. J. Barre; "Problems of Corn Storage in the Ever-Normal Granary Program," by Wm. McArthur; "New Applications of Extended Surface Heating in Grain Drying," by Geo. J. Burkhardt; and "Methods for Drying Grain on the Farm," by C. F. Kelly.

In the afternoon session of the same day the farm structures men will hear and discuss a miscellany of subjects, including "Some Tests of Proper Methods of Clinching Nailed Joints," by J. C. Wooley; "Protection of Farm Buildings Against Lightning," by W. J. Alcock; "Designing Farm Buildings for Wind Resistance," by Henry Giese; "A Year-Round Brooder House for Pigs," by F. E. Overson; "Progress Report on Tests of Paints for Metal Surfaces," by Geo. C. Bartells; and "The Use of Aluminum Paint on Farm Buildings and Equipment," by a speaker not yet named.

On Wednesday the structures program will open with J. R. McCalmont reporting on "Silo Pressures and Temperatures with Grass Silage." S. A. Witzel will follow, opening up the subject of "The One-Story Dairy Barn." This is to be discussed at length by R. G. Ferris, A. E. Waterman, J. D. Long, and others.

"Condensation Problems in Farm Buildings," by R. P. A. Johnson, in the fourth and final session of the Farm Structures Division, will be discussed by G. B. Hanson, Wm. Rees, J. F. Schaffhausen, E. C. Lloyd, and D. D. Grassick, each representing experience with a different insulating material.

POWER AND MACHINERY

In the Power and Machinery Division opener the subjects and speakers will be "Grading Hybrid Seed Corn for Planting," by R. H. Reed; "Labor Efficiency and Power Economy in Corn Production," by J. B. Davidson; "Experience in the Utilization of Farm Machinery for Greater Efficiency," by B. Gwynne Burr; and "Disk Tool Characteristics and Possible Improvements," by A. W. Clyde.

Fuels and tires will be featured when the power and machinery men reconvene for their first afternoon session. C. N. Hinkle will present, as a contribution of the A.S.A.E. Committee on Tractor Fuels, "Results of a Nation-Wide Study of Laws and Regulations Governing Low-Grade Tractor Fuels." "Proposed Specifications of a Standard Low-Grade Tractor Fuel" will be introduced by C. E. Frudden. C. G. Krieger will report on a "Correlated Analysis of Tractor Engine Fuels by Theoretical Values."

The tire half of this session will include a "Progress Report of a Study of Pneumatic Tires for Transport Wheels on Agricultural Machines," by E. G. McKibben. A "Progress Report of Pneumatic Tractor Tire Profile Studies" will be made by R. H. Wileman. E. L. Barger and J. Roberts will conclude the session with a paper on "The Effect of Wear of Pneumatic Tires on Tractor Performance."

Forage crop handling will dominate the second day of the power and machinery program. A symposium on "Forage Crop Drying," in the morning will include papers on "Some Carotene, Protein, and Fiber Values of Dehydrated Alfalfa Meals," by Virgil Wodicka and Lamar Kishlar; "Results of Research Work in the Natural Drying of Forage Crops," by T. N. Jones; "Development of a Crushing Machine for Forage Crops," by R. H. Reed; "Development of a Forage Crop Dehydrator," by Wm. Aitkenhead; and "Effectiveness of Low-Cost Hay Drying Installations," by J. W. Weaver, Jr.

An interim subject opening the afternoon session will be "Observations of Agricultural Engineering Interest from a European Tour," by E. W. Lehmann and S. H. McCrory. Getting back to forage problems, the power and machinery men will devote the balance of their final session to grass silage. J. W. Bartlett will present an illustrated lecture entitled "Seven Years' Experience in the Preservation of Grass Silage," and F. W. Duffee will introduce the subject of "Machinery and Equipment for Handling Grass Silage."

RURAL ELECTRIFICATION

A session on extension will open the program of the Rural Electric Division, Thursday, December 1. Scheduled papers include "An Agricultural Extension Project in Rural Electrification," by S. A. Anderson; "A Vocational Agricultural Project in Rural Electrification," by Jos. S. Webb; "What Constitutes a Good Rural Electrification Extension Program," by M. M. Johns; and "Electrified Farm Equipment Tours," by D. W. Teare and H. H. Beaty.

Technical progress will be emphasized in the next period of the rural electric program, the afternoon of December 1. Contributions listed are "New Farm Electrification Developments," by J. P. Schaenzer; "A Research Study of Electric Fence Controllers," by H. W. Riley and Sidney Krasik; "Specifications for Electric Fence," by F. W. Duffee; and a demonstration of the effect of ultra-violet light on eggs, conducted by Lee Lloyd.

A round table on "Cooperation between Private Industry and Educational Institutions in Rural Electrification" is scheduled for Thursday evening.

Friday morning S. B. Darnell will open the session with "An Engineering Analysis of Electrical Uses on the Farm." Frank M. Mason will review Michigan experience in "Electrifarming for Profit." "Some Rural Electrification Proving Farm Results" will be reported by B. P. Hess.

The Rural Electric Division will conclude its program with a Friday afternoon session on some specific phases of rural electric applications, including "Refrigerated Locker Storage of Perishable Farm Products," by A. A. Geiger; "Food Preparation and Utilization Aspects of Refrigerated Locker Storages," by Dr. Sybil Woodruff; and "Organization of a Farm Water System and Plumbing Program," by Willard J. Luff.

SOIL AND WATER CONSERVATION

Water, as it occurs on farms, will hold the center of interest in the opening session of the Soil and Water Conservation Division, December 1. Papers planned include "Aims and Objectives of the Small Water Facilities Program," by W. W. McLaughlin; "Planning for Small Water Facilities," by Francis R. Kenney; "The Engineering Planning and Construction of Small Water Facilities," by E. R. Kinnear; and "The Relation of Small Water Facilities to Agricultural Relief and Adjustment," by H. H. Gordon.

In the afternoon of the same day the conservation men will hear and discuss "Tillage Practices for Wind Erosion Control in North Dakota," by H. F. McColly; "Planning Farm Surface Drainage Systems by Watersheds," by James J. Coyle; "Terrace Outlet Channel Studies" by H. L. Cook; and "Hydrologic Studies at the Waco (Texas) Experiment Station," by R. W. Baird.

At an evening roundtable the same day the Division will consider committee reports and two papers, "Reservoirs and Ponds—Legal Investigations and Compliance with State Rights," by Frank Kimball and John S. Glass; and "Investigations for Plans, Designs, and Construction," by J. W. Jourdan and C. A. Haskins.

Drainage will have its inning when the soil and water conservation group reconvenes on Friday morning. Subjects and speakers include "Equipment for Maintaining Small Drainage Channels," by D. A. Isler; "Drainage Problems in Indiana," by I. D. Mayer; "Observations of Drainage Work in Europe," by S. H. McCrory; "Explosives in Drainage Work," by L. F. Livingston; and "Hydraulic Factors in Drainage Channels," by J. G. Sutton.

Irrigation will be the subject considered at the Division's final session, Friday afternoon, December 2. Discussion starters will be papers on "Supplementary Irrigation on the Atlantic Coast," by F. E. Staebner; "Low-Pressures, Low-Power Sprinkling Irrigation for Small Farms," by F. W. Duffee; and "Supplementary Irrigation in the Central States," by Virgil Overholt.

(News continued on page 500)

WHY FARMERS WANT

"USES 10 GALLONS LESS GASOLINE A DAY TRAVELS ¼ MILE AN HOUR FASTER"

GETS 2¼ MILES MORE every 10-hour day out of his high compression tractor. Because of side-by-side tests in the same field, Florian Polcyn, Gorham, Kansas, found out just how much better a high compression tractor is.

IN THE SAME KANSAS WHEATFIELD, PULLING THE SAME LOAD, FLORIAN POLCYN'S HIGH COMPRESSION TRACTOR BEATS TWO LOW COMPRESSION TRACTORS

BECAUSE the Polcyn Brothers of Gorham, Kansas, use three tractors to work 1300 acres, they have had a unique opportunity to test the merits of high compression and low compression tractors in the same field. Says Florian (Mike) Polcyn:

"We burn regular-grade gasoline in all of them. Our new high compression Minneapolis-Moline tractor uses 10 gallons less a day than either of the other two tractors, and it will gain a quarter of a mile in an hour, plowing in the same field. In the course of a 10-hour day, the new high compressioned tractor actually goes 2½ miles farther.

"This saving in gasoline and gain in additional distance holds good whether we are plowing with a nine-foot one-way plow, or plowing with a five-bottom moldboard plow."

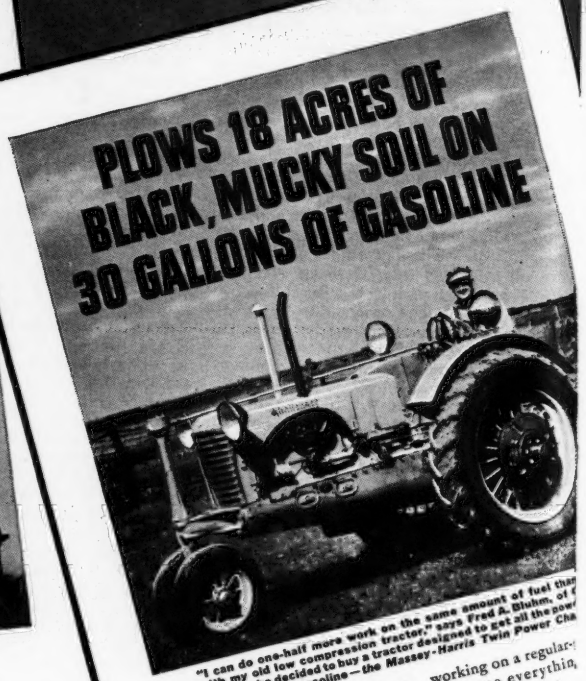
To get added power from your tractor, ask your dealer or write your manufacturer today about getting high compression ("altitude") pistons or cylinder head to change it over to high compression. Easier yet, see that your next tractor has high compression pistons or cylinder head, which most manufacturers offer at no additional cost.

SEND FOR FREE 24-PAGE BOOKLET

Write today for FREE illustrated 24-page booklet "How To Get More Tractor Power." It tells you: How To Reduce Tractor Costs. Why Some Fuels Produce More Power. How High Compression Works. How To Do More Work In The Same Time. Send a penny postcard now to Dept. T-1, Ethyl Gasoline Corporation, Chrysler Building, New York, N. Y., manufacturers of anti-knock fluids for premium and regular-grade gasolines.

It pays to buy **GOOD GASOLINE FOR CARS, TRUCKS AND TRACTORS**

PLOWS 18 ACRES OF BLACK, MUCKY SOIL ON 30 GALLONS OF GASOLINE



"I can do one-half more work on the same amount of fuel than with my old low compression tractor," says Fred A. Bluhm, of Illinois, who decided to buy a tractor designed to get all the power regular-grade gasoline—the Massey-Harris Twin Power Challenger.

WHEN a company designs a tractor to burn regular-grade gasoline only, what happens? Does it actually *deliver* more power at the drawbar or belt? Is it easier on your pocketbook because it gets more power out of the fuel it uses? Ask Fred A. Bluhm, of Ogden, Illinois, and here's what he'll tell you:

"For several years, I have been deciding on which new tractor to buy. I looked over a number of tractors and selected the Massey-Harris Twin Power Challenger. With this tractor burning regular-grade gasoline, I can do one-half more work on the same amount of fuel than I did with my old low compression tractor. For instance, my old low compression tractor would plow 12 acres and use 30 gallons of fuel in 12 hours. My new Massey-Harris Twin Power tractor will plow 18 acres in the same number of hours on 30 gallons of regular-grade gasoline.

"I farm 160 acres of black, mucky soil, where plowing is plenty tough, and grow corn, soy beans, and oats. We operate a 12-foot combine and a 2-row corn picker. My Twin Power Massey-Harris Challenger tractor working on a regular-[illegible] gives me everythin[illegible] tractor."

To get the extra [illegible] omy of gasoline in[illegible] sure that the next t[illegible] been designed to [illegible] ciently. This may [illegible] engine features—[illegible] type manifold, [illegible] cylinder head o[illegible] mobile" type c[illegible] the added pow[illegible] oline pay you[illegible] ent tractor by [illegible] tons or a hi[illegible] head at the [illegible] ing the ma[illegible] fold to the

SEND F

Write t[illegible] page bo[illegible] tor Po[illegible] duce "[illegible] Prod[illegible] pres[illegible] Wor[illegible] pos[illegible] Ga[illegible] in[illegible] of [illegible] re[illegible]

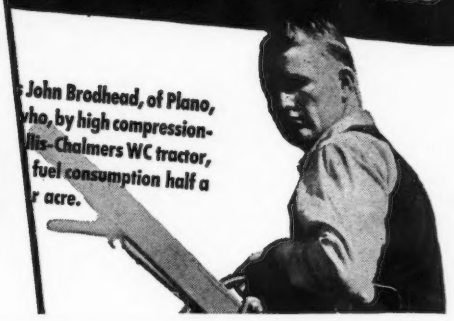
IT PAYS TO BUY G[illegible] FOR CARS, TRUCK[illegible]

HIGH COMPRESSION TRACTORS

MOWS 90 ACRES OF HAY A DAY ON 16 GALLONS OF GASOLINE

"FROM NOW ON it is high compression and good gasoline for me" says Louis Buzzine, who farms 3,000 acres near Patterson, Cal., with two high compression Oliver "70" tractors.

"I PLOW 20 ACRES IN A 12-HOUR DAY ON 30 GALLONS OF GAS"



John Brodhead, of Plano, who, by high compression-Allis-Chalmers WC tractor, fuel consumption half a acre.

MR. BUZZIN lined wallo about making ha when he change sion tractors an made 28% mor used 27% less compares his t Oliver 70's, b gasoline, with sion tractors, b "I can truth high compres As the old say the pudding had plenty to "During th acres of hay mowers. Wit sion tractors we burned fuel, mowin mowers in high comp operating 16 gallons of hay, pull Besides th grade fuel consum motor oil between changes whereas

A total circulation of sixty-one million advertisements of the Ethyl Gasoline Corporation is helping you to make high compression tractor sales in 1938. That's an average of more than eight for every farm in the United States. This sales power goes to work for you when you join the rapidly growing trend to high compression tractors and good gasoline.

IT PAYS TO BUY GOOD GASOLINE FOR CARS, TRUCKS AND TRACTORS

year, I armers. heat, I e-way,

postcard now to Dept. TB-33, Ethyl Gasoline Corporation, Chrysler Building, New York, N.Y., manufacturers of anti-knock fluids for premium and regular-grade gasolines.

IY GOOD GASOLINE

Washington, D. C., Section in First Fall Meeting

A LUNCHEON meeting at the Harrington Hotel, October 12, marked the opening of a new year in the Washington, D. C., Section of the A.S.A.E. In the absence of H. E. Roethe, section chairman, A. V. Krewatch, vice-chairman, presided.

M. L. Nichols gave a brief sketch of agricultural engineering research activities in the U. S. Soil Conservation Service.

New engineering work required in setting up building standards and making appraisals for new farm structures to be built under the new "housing loans" was reported by C. D. Kinsman.

Mr. Krewatch presented a summary of a survey of coordinative effort to eliminate waste in rural electrification research. He also reported briefly on the North Atlantic Section meeting and the coincident hurricane in that area.

Tentative plans for a November meeting featuring an account, by S. H. McCrory, of his recent European trip, were announced.

A. T. Mitchelson, of the Berkeley, Calif., office of the irrigation division, U. S. Bureau of Agricultural Engineering, was the only out-of-town guest at the meeting. Miss Mary Taylor and Miss H. E. Sater, the two ladies present, were introduced.

Walter H. Redit is secretary-treasurer of the Section.

Georgia State Section Meets

THE regular fall meeting of the Georgia State Section of the American Society of Agricultural Engineers was held on Saturday evening, October 15. Twenty engineers and their wives or lady friends attended a banquet and entertainment in Dawson Hall at 7 o'clock, after which a business session occupied the attention of the group.

G. I. Johnson, chairman of the Section, officiated as toastmaster at the banquet. J. L. Calhoun served as chairman of the program committee and F. B. Lanham, as chairman of the banquet committee.

R. H. Driftmier gave a report of his trip to the meeting of the A.S.A.E. in California last June. W. N. Danner reported on the student enrollment. F. W. Peikert gave an account of the A.S.A.E. Summer School in Industry, attended by himself and two agricultural engineering students.

Livingston Blasts White Pill for Hole-in-One

ACCORDING to a belated report to the Editor, Larry (One-Shot) Livingston, a past-president of the A.S.A.E., gave an unusual agricultural engineering extension demonstration July 14, at the Broadview Country Club, Lincoln, Nebr., before a small but appreciative audience.

Presenting a demonstration setup requiring the transfer of a small but obstinate white hardhead some one hundred fifty yards from a certain level grassy area to a small depression marked by a flag, Mr. Livingston surveyed the situation, considering ways and means of accomplishing the result with true engineering dispatch and efficiency.

Based on careful analysis of the situation as he found it, and possibly influenced by a predisposition to the method, he decided to move the hardhead as required with one direct application of just the right amount of energy. Calculating that amount with a professional nicety, and with due regard for distance, elevation, weight involved, air resistance, windage, barometer reading, angle of rise, angle of fall, rebound, rolling resistance, lighting effects, and last but not least, the human factors involved, Mr. Livingston next determined the specifications of the load required to accomplish the desired result. Then he selected from his portable kit a charge which he had prepared for the occasion. Dropping to all fours, he obtained a close-up view which revealed to his satisfaction just how far under the center of gravity of the object the center of impact should be applied.

Finally, with a minimum of explanatory remarks and a firm resolve to let the result speak for the efficacy of his methods, he was ready. With due regard for public safety, and possibly as a challenge to yonder depression to get out of the way if it could, he filled his lungs and shouted a loud "Fore." Ceremoniously he touched off the figurative fuse. There was a swishing sound, followed by an explosive sharp crack. Precisely as the sun rises in the east and sets in the west, the troublesome little white hardhead rose, sailed, arched, fell, bounced, rolled, poised on the brink the merest instant, its force spent, and then dropped into the hole which was its destination.

"That shot," said Mr. Livingston, hiding his surprise, turning with becoming modesty to his awestruck little band of followers, and driving home another lesson in profiting from experience, "really should have had another inch-ounce of energy as an added factor of safety, but it will serve to illustrate some of the possible advantages of direct power properly applied to the solution of a rural problem."

WPA Publishes Summary for Index of Research

THE results of some 2,000 research projects carried on as part of the federal work relief program are summarized briefly in a digest and index which has been published by the Works Progress Administration. This volume of 291 pages contains a concise statement of the principal conclusions of each study and an alphabetical subject index to the contents. The reports on these projects touch upon nearly every field of natural and social science and many of them have appeared in the form of articles in scholarly journals. However, several hundred of the reports summarized in this index are in manuscript form, and arrangements have been made with the American Documentation Institute whereby microfilm copies of the original reports will be furnished at nominal rates for the use of research specialists. A small edition of this volume has been prepared for distribution to the larger public and university libraries where it will be available for reference, and for government departments, industrial concerns, and research foundations. A limited supply of copies of this Index of Research Projects are still available. Requests should be addressed to the Works Progress Administration in Washington.

Washington News Letter

from AMERICAN ENGINEERING COUNCIL

INVENTION AND THE ENGINEERS' RELATION TO IT

THE second forum of American Engineering Council will be held in Detroit on November 11th at the Hotel Statler with the Michigan Engineering Society acting as host. As earlier announced, the forums of American Engineering Council have a fundamental purpose, namely, to provide an opportunity for engineers to discuss with other public and professional men basic problems of primary engineering character, which have a public interest. The proceedings of the forum in compact form constitute the engineers' contribution to public questions discussed and are distributed to those in public authority, as expressions of opinion of engineers on these subjects.

The first forum was held in Philadelphia on May 13 on the subject, "Employment and the Engineers' Relation to It." The second forum, like the first, will open with a luncheon. Greetings from the president of the Michigan Engineering Society, Dean H. B. Dirks, will be acknowledged by Dr. William McClellan, president of American Engineering Council. The chairman of the afternoon session is C. J. Freund, dean of the College of Engineering, University of Detroit.

This program has been developed with the cooperation of chairman R. S. McBride, of the AEC patents committee and brings together a representative group of engineers and others interested in this broad subject from a public point of view. F. A. Allner, chairman, AEC committee on public affairs, which is in charge of the forums, will present a brief statement of the purpose and functions. K. H. Condit, who opens the session is former editor of AMERICAN MACHINIST, now associated with the National Industrial Conference Board as assistant to the president. Dr. Lyman J. Briggs, director of the National Bureau of Standards, will present a review not only of the place of the Bureau of Standards in research but of other government bureaus, which touch the field of engineering and scientific research, as well as in the fields of medicine and other scientific investigation. G. A. Boyd, who is associated with Dr. C. F. Kettering in the Research Laboratories Division of General Motors Corporation, will present a picture of development of research in private business, with especial reference to the organization and development of research projects which lead to application.

The evening session is presided over by Dr. William McClellan, President of American Engineering Council. Harry H. Semmes, long a member of the patent bar and present chairman of the patents committee of the American Bar Association, will open a discussion with a summary of the patents survey being undertaken under his direction by members of the *(Continued on page 502)*

ASAE Meetings Calendar

November 28-December 2—Fall meeting, technical divisions, The Stevens, Chicago, Illinois.

February 1-3, 1939—Southern Section, New Orleans, La.

June 19-22, 1939—Annual meeting, University Farm, St. Paul, Minn.

PULLING-POWER

"RATES" FIRST ON THIS 2-TRACTOR FARM!

Raising corn and soybeans, F. E. and Phillip Walker found that more than 85% of their field work could best be done by a pulling tractor. And that a small cultivating tractor could advantageously do the light row crop work, consisting of less than 15% of their total.

So they traded off 2 light-duty tractors, kept one cultivating tractor, and bought a "Caterpillar" Diesel D4 Tractor for their heavy field work on their 640 acres. The first year, their Diesel D4 did all of this heavy work on only $72.50 worth of fuel, saving $525.00 *on fuel expense alone* over their former spark-ignition wheel-type tractors. Their experience is multiplied by hundreds, in the corn belt.

"Caterpillar" builds a track-type Diesel Tractor line of 5 sizes—ranging from 25 to 95 drawbar horsepower. Thus, this company is equipped to recommend the size of pulling tractor needed to team with a cultivating tractor—to give any 2-tractor row-crop farm an economical and efficient power set-up that takes full advantage of modern engineering progress.

CATERPILLAR

REG. U. S. PAT. OFF.

TRACTOR CO. • PEORIA, ILLINOIS

DIESEL ENGINES

TRACK TYPE TRACTORS • TERRACERS

Washington News Letter

(Continued from page 500)

patent bar, and Dr. F. B. Jewett, vice-president of the American Telephone and Telegraph Company, in charge of research for that organization, will speak on the interrelation between scientific research and patents. Dr. Jewett is a member of the AEC patents committee.

Each of these presentations of a specific subject, both in the afternoon and evening sessions, will be discussed by invitation by representative men from industry, the patent bar, engineering organizations, and directors of research, with the thought of bringing as much illustrative material to the symposium as possible in the various fields of engineering including chemical, mechanical, and electrical research, stream pollution, etc.

The forum will be closed by the chairman of the evening session, who will summarize the results of the afternoon and evening discussions.

The end product of this forum will be published as a pamphlet similar in character to the one issued after the Philadelphia forum, and will constitute a factual survey of the general subject which American Engineering Council will contribute for the benefit of industrialists and public representatives including legislative and administrative officers of government.

This contribution, it is hoped, will be a timely one, since the facts presented and the discussions should provide the viewpoint and opinion of engineers and allied professional men on a subject which no doubt will receive a great deal of attention by the so-called temporary national economic committee, headed by Senator O'Mahoney. It will be recalled that Senator O'Mahoney was one of the principal speakers at the annual meeting of American Engineering Council held in Washington in January 1937.

The Michigan Engineering Society is inviting to the forum not only the members of the state society, but invitations have also been extended to the several engineering societies and the sections of the national societies in the State of Michigan and in the immediate vicinity. The public, as well as all engineers, are cordially invited to the meeting, for which there is no registration charge.

HOW OUR NATIONAL INCOME IS DISTRIBUTED

One of the main objectives of our present administration is to so regulate the functioning of our economic mechanism as to bring about a more equitable distribution of income. With this in view, the administration, through utterances and statements in the press, has made the American nation conscious of the existing very uneven distribution of our national income. There is the conviction that extreme inequality of income spells extreme lack of mass-buying capacity, which is at the very core of our prolonged depression.

Just how extreme the uneven distribution of income was among the various groups of our people was not known. There was no up-to-date collected statistical information that would show in approximately exact figures how the national income was being distributed. The challenge that one-third of our nation is "ill-housed, ill-clad and ill-nourished" was too general and required facts to substantiate it.

With this in view, the national resources committee undertook a study of the income levels for the three main classes of the American people—the poor, the middle class, and the wealthy, two years ago. The study is based mainly on the income data collected in a WPA survey of consumers' purchases made by the Bureau of Home Economics and the Bureau of Labor Statistics.

Results of this study are embodied in a report of National Resources Committee entitled, "Consumer Incomes in the United States, Their Distribution in 1935-36" released Sept. 4, 1938. The report is of great importance to everyone. It is most comprehensive in its scope, containing the largest amount of first-hand facts which has ever been collected for such a study of income distribution. Whatever one might be inclined to think of its purport and outcome as far as legislative action is concerned, there is no question of its being free from bias either in the collection of data or its tabulation and presentation.

There is no question that this study will serve as a basis for legislation regarding wages and taxes. As the report points out: "those concerned with the living standards of the people need more accurate information on the extent to which shortage of income brings poverty damaging to health and happiness. Law-making bodies striving to apportion taxes equitably and without damage to the processes of industry need to know what will swell or deplete the stream. . . . Any attempt on the part of the government or business to grapple with basic economic problems must rely heavily on what can be learned of the distribution of income among the various groups of the nation's consumers."

Estimates of the income distribution for the period covered were based directly upon data on family incomes collected in the study of consumer purchases and supplemented by data from other sources. Over 300,000 families and individuals living in cities and villages, and on farms in thirty different states were canvassed in this study. The communities covered include 51 cities, 140 villages, and 66 farm counties. The data thus secured served as a representative sample to give a reliable picture of how the incomes of the American people vary.

Although the study contends that it gives the most complete picture of the distribution of the national income among the American people that was ever presented, it concedes that the statistical material on which it is based is subject to "many limitations and shortcomings." Many things had to be assumed from the "representative sample."

The most striking generalization in this study is that it divides the nation into thirds. It alludes to the President's generalized statement of "ill-housed, ill-clad, ill-nourished third" of our people. It must be borne in mind, however, that the division of the people into thirds for the sake of indicating disparity of income and income contrasts is arbitrary.

The study assumes, for the sake of expediency, that the national income is first "produced" and then "distributed." The process of distribution in our economy is indissolubly linked with the process of production.

Like all such statistical studies, this study will probably raise more questions than it answers. Of course, the study does not interpret nor does it attempt to suggest any remedies for the great disparities in incomes which it so dramatically sets forth in tables and charts. The great question tacitly raised, however, is how to eliminate the existing extreme inequality of the distribution of income, especially that of the poorest third. Some contend that the solution of the problem can be met only by increasing our national productivity, individually and collectively. There is also the awareness that further studies will be made before any recommendations will be suggested to Congress as to a policy for promoting a more equitable distribution of the national income. Time will tell.

NINETEENTH ANNUAL ASSEMBLY TO BE CONDUCTED AS THIRD FORUM

The Nineteenth Annual Assembly of the American Engineering Council will convene in Washington at the Hotel Mayflower January 12, 13, and 14, 1939. The first four sessions of the Assembly held on Thursday morning and afternoon and Friday morning and afternoon, will be conducted as the third forum of American Engineering Council, on a series of public questions under the leadership of committees of the Council. The fifth session—the Annual All Engineers' Dinner—will be held on Friday evening. The business session of Council will be conducted as the sixth session of the Assembly on Saturday morning, January 14.

Under the direction of the president, the executive committee and the committee on public affairs, a series of topics with leaders of discussion is being developed. These topics include "The Economic Status of the Engineer", which will be under the direction of the committee on economic status; "Engineering Factors in the Size of Business", under the direction of the committee on engineering economics; "Public and Private Construction and the Engineers' Relation to Them", under the direction of the public works committee; "National Planning and the Engineers' Relation to It", under the direction of the public affairs committee.

The sixth and closing session will include in addition to the reports of the executive secretary, president, and other committees, a report of the public affairs committee, presenting the results of the deliberations of the two preceding days, as well as a summary of the first and second forums.

* * *

A summary analysis of the digest of the report entitled "The Future of State Planning" issued by the National Resources Committee, July 1938, is included in the AEC Bulletin for October 1938, but is too long to reproduce here. Copies will be furnished on request.—EDITOR.

Chemurgic Broadcasts

THROUGH the cooperation of the Columbia Broadcasting System, *chemurgy* will go on the air over a nation-wide network of eighty stations beginning Sunday, November 13, 1:45 to 2:00 p.m. The series of broadcasts will consist of 13 programs, under the title "The Farmer Takes the Mike."

Representatives of the Chemurgic Council, U. S. Department of Agriculture, state colleges, industrial firms, and farmers from many sections of the country will participate in the broadcasts. The programs will be in the nature of forums where farmers will have an opportunity to question chemurgists and scientists as to what is being done to help find new and industrial uses for American farm crops.

The first program will originate at Washington, D. C. Wheeler McMillen, president of National Farm Chemurgic Council, will present the series with a brief talk, following which a Maryland farmer will question authorities of the Department of Agriculture concerning the new farm-industrial research laboratories.

(Additional news on page 504)

DOING A BIG JOB IN A BIG WAY!

Save time and tires with Goodyear "L. T." Semi Drop-Center Rims. Most efficient rim built—easiest to apply and remove tires. No special tools needed. Also available for dealer change-overs.

ARE you interested in selling new tractors?

Then every one of Goodyear's big tractor-tire ads is "right up your alley"!

For, every ad headlines: BUY A *NEW TRACTOR* ON GOODYEARS.

That's how *Goodyear* tackles the job of selling tractor tires—in a big way—selling *new tractors* as well as this great new Sure-Grip tire.

The way for you to take advantage of this fast-stepping program—*in a big way*—is to co-operate. On all your factory orders—

Specify—

ONLY the GOODYEAR SURE-GRIP provides ALL these advantages

OPEN-CENTER TREAD—no pockets to pack up and cause slip; full self-cleaning; better penetration

WIDER TREAD – greater traction; more pull

BETTER GRIP – lugs are deeper cut and wider spaced to dig in without shearing off soil

SMOOTH RIDING—lug bars overlap evenly at center, giving continuous support on hard roads

GREATER FLEXIBILITY – conforms better to rough ground

REENFORCED LUGS – buttressed at both sides to prevent undercutting

WEATHERPROOF RUBBER – resists effects of sun, weather and barnyard acids

SUPERTWIST CORD in every ply

GOODYEAR FARM RADIO NEWS

over N. B. C. blue network, 1:15 P. M., E. S. T.—12:15 C. S. T.—immediately following the widely popular National Farm & Home Hour. Programs feature information of *local interest*—news about crop conditions, commodity prices, shipping, weather forecasts, etc. Broadcasts daily Monday through Friday. Tune in!

GOODYEAR

TRACTOR AND IMPLEMENT TIRES

What Agricultural Engineers Are Doing

(Continued from page 496)

A drainage conference of superintendents and engineers of the Illinois Drainage Camps was held at Camp D-5, Havana, Ill., on October 13, 14, and 15. Principal speakers addressing the group included: S. M. Lauderdale, CCC safety engineer from the office of Director Fechner; Colonel Jos. A. Atkins, U. S. Army, district commander, Jefferson Barracks CCC District; John McLaren, liaison officer, Sixth Corps Area; Sanford Sellers, Jr., educational adviser, Sixth Corps Area, CCC; E. W. Lehmann, G. W. Pickels, and J. J. Pieper of the University of Illinois; and J. C. Sutton, district engineer. Local drainage districts were well represented throughout the conference by approximately 40 engineers and commissioners. In a joint session at Havana during the conference, commissioners representing drainage districts in west central Illinois, adopted a resolution presented to Mr. Sutton, through their chairman, W. Y. Dow, of the Thompson Lake District, attesting to their appreciation of the assistance and efficient work rendered by the drainage camps in their districts.

* * *

Central District drainage camps report the following work accomplished in September: 3,435,000 sq yd of clearing, 1,390,000 cu yd of excavation and embankment, 37,600 lin ft of tile reconditioning, and 22,354 man-days on structural and miscellaneous maintenance work. A total of $78,000 was furnished by the drainage organizations during September.

* * *

At the National Safety Council meeting in Chicago on October 11 Wallace Ashby presented a paper on "Fire Protective Construction on the Farm." He visited the corn storage projects at Urbana and Ames, the potato storage project at Fargo, North Dakota, and the farmhouse remodeling work at Madison, Wisconsin.

* * *

T. A. H. Miller visited Massachusetts and Connecticut to observe the storm damage to farm buildings. Most of these states were covered in company with W. C. Harrington of Massachusetts and H. E. Pinches of Connecticut. Data were collected which showed faulty construction in buildings which were damaged or destroyed by the hurricane. In many instances if the buildings had been properly anchored and the component parts securely fastened together, there might have been less damage to the structure.

* * *

W. P. Green returned from a trip with a shipment of citrus fruit from California to New York. Readings of temperatures and air velocities were made in cars employing various methods of icing. Mr. Green recently accepted a position in the mechanical engineering department of the University of Maryland and took up his duties there October 17.

* * *

FROM THE UNIVERSITY OF NEBRASKA

Agricultural engineering progress reports Nos. 2, 3, and 4, written by F. D. Yung, deal with "Motor Overload Signal," "Tank Heater Studies," and "Studies of Insulated Electric Brooders." These mimeographs indicate that additional work is to be done on the subjects concerned. Mr. Yung offers to make the reports available to interested agricultural engineers.

William N. Rumely Memorialized by A.S.M.E.

MEMORIAL biographies of deceased members of the American Society of Mechanical Engineers, published in October 1938 as Part II, Vol. 60, A.S.M.E. Transactions, include a biography of William Nicholas Rumely. (1858-1936) who was long a member of that society, and who was elected an Honorary Member of the American Society of Agricultural Engineers in 1933.

The A.S.M.E. has advised that clippings of this biography are available. A.S.A.E. headquarters will be glad to request copies for members who may wish to preserve this record of Mr. Rumely's life and works.

U.S.D.A. Yearbook, 1938

DISTRIBUTION of the new Yearbook, called "Soils and Men" began in the late summer.

The A.S.A.E. is represented among the authors by R. B. Gray who wrote on "Tillage Machinery," M. L. Nichols and T. B. Chambers prepared the paper "Mechanical Measures of Erosion Control" and M. R. Lewis is a joint author of "Irrigation in the United States." "Drainage in the Humid Regions" was prepared by John R. Haswell. Among the illustrations in this article is one of John Johnston, the early tile drainer and also, one of his marker dedicated by the North Atlantic Section of the Society at their 1935 meeting. The drainage article makes use of the "Literature Cited" list and among others at least ten members of the Society, past and present, are noted.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the October issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

O. E. Brock, Jr., farm service representative, Louisiana Power and Light Company, 142 Delaronde Street, Station "A", New Orleans, La.

J. G. Hamner, engineering apprentice, Caterpillar Tractor Company, Peoria, Ill. (Mail) 117 Jackson Court.

Victor Hopeman, foreman of Caterpillar Proving Grounds, Caterpillar Tractor Company, E. Peoria, Ill. (Mail) R. No. 104.

Andrew J. Longley, assistant agricultural engineer, (Project Kan-4) Soil Conservation Service, U. S. Department of Agriculture. (Mail) 728 N. Prospect Street, Liberal, Kans.

Belon S. Pierce, professor of manual arts, Newton High School, Newton, Miss.

Imre de Razso, assistant professor of agricultural engineering Royal Hungarian Academy of Agriculture, Magyarovar, Hungary.

E. F. Redding, extension engineer, Extension Service, New Mexico College of Agriculture. (Mail) 711 West May, Las Cruces, N.M.

TRANSFER OF GRADE

G. Douglas Jones, agricultural engineer, Cleveland Tractor Company, Cleveland, Ohio. (Member to Fellow)

J. R. McCalmont, junior engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) 4727 24th Street, N., Arlington, Va. (Assoc. Mem. to Member)

Student Branch News

THE Georgia Student Branch of the American Society of Agricultural Engineers held its first regular meeting for the year 1938-39 Monday evening, October 10, in the club room. The meeting was called to order by B. E. Dixson, president. In a short business meeting the club voted to have a page in the Pandora, the University yearbook, and elected Allen Burson to fill a vacant office on the "Georgia Agriculturist" staff.

The program for the evening consisted of short talks by the faculty of the department.

"Facts About the University System" was the subject of a talk by R. H. Driftmier, head of the department. He pointed out that the university system consists of seven senior colleges with an enrollment of 9,736, six junior colleges with an enrollment of 2,379, and three negro colleges with an enrollment of 742, giving a total enrollment of 12,857.

The university system has built sixty-three buildings since January 1936. Thirty-three of these were designed by R. E. Hitchcock and R. H. Driftmier, and fifty-eight constructed with R. H. Driftmier as supervising engineer and W. B. Lamb as assistant supervising engineer.

W. N. Danner, Jr., spoke on the "Importance of Student Branches of the American Society of Agricultural Engineers," showing how taking an active part in their Branch will help develop students along lines which are not developed in classroom work.

In a talk on "How to Study," U. H. Davenport pointed out two important things that make studying easy and profitable. They were interest in the subject and confidence in one's ability to master the subject.

F. W. Peikert spoke of "The Agricultural Engineer in Industry," indicating that the primary requirements are inborn qualifications, sufficient basic training, ability to cooperate, and a willingness to work.

Remarks on "Research Activities of the Department," by J. W. Simons, covered active research projects including housing, storage of grain sorghums, reaper attachment for a mowing machine, crimson clover seed harvester, and control of soil erosion.

W. N. McAdams reported on "The Clemson Branch of the American Society of American Agricultural Engineers."

"A Group of Don'ts to Be Sure Not to Follow," a talk by W. E. Hudson, pointed to efficient preparation as a prerequisite to success in life.

The first regular meeting of the year was well attended and considerable interest was evident. The program committee hopes to keep the interest of the members at a high peak throughout the year.—*Boyce Dyer, Scribe.*

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Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted may be addressed to the publisher thereof or to AGRICULTURAL ENGINEERING

POWER REQUIREMENTS FOR FREEZING ICE CREAM, *W. J. Caulfield, C. K. Otis, and W. H. Martin.* Jour. Dairy Sci., 20 (1937), No. 10, pp. 645-655, figs. 4. The Kansas Experiment Station has investigated the effects of various factors on the operating efficiency of a 40-qt, direct-expansion ice cream freezer. Reduction of the temperature at which the refrigerant was cut off from 25.5 F to 24 or 22.5 F resulted in a decline in dasher speed, an increase in the time required to reach a 100 per cent overrun, and a marked increase in the energy input to the motor and the total power used in freezing. The quality of the ice cream was slightly improved at the lower temperature. The addition of proper amounts of stabilizers to a standard mix slightly increased the freezing time and the total power required. The addition of egg yolk to a standard mix materially reduced the time required to reach 100 per cent overrun and also the total power required, but increased the energy input to the motor.

Substituting a 5-hp for the 3-hp motor improved the operating efficiency of the freezer without increasing the total power consumed. The larger motor was never overloaded, whereas the 3-hp motor was seriously overloaded, particularly when a mix containing egg yolk was frozen and the refrigerant cut off at 24 F. Increasing the dasher speed from 170 to 200 rpm resulted in a slight saving in the time required to reach 100 per cent overrun but did not significantly affect the quality of the ice cream or the total power requirement.

ECONOMIC BENEFITS OF IRRIGATION FROM THE KINGSLEY (KEYSTONE) RESERVOIR, *F. Miller and H. C. Filley.* Nebraska Sta. Bul. 311 (1937), pp. 57, figs. 4. The central Nebraska public power and irrigation project, of which the Kingsley Reservoir is a part, is described. "From this storage of some 2,000,000 acre-ft of water, normally lost in runoff during the dormant season, 600 mi of canal will carry irrigation water to 500,000 acres in the Platte River watershed of central Nebraska. The estimated return flow, taken from the river lower in its course, will supply water to an additional 250,000 acres." In addition it is estimated that 150,000 acres can be watered from electrically driven pumps with power generated by the impounded waters.

The soils, climate, crops, present development, etc., of the area to be irrigated are described. Using past rainfall and crop records, yields of crops under irrigation in the area and in similar counties of the state, experimental data, etc., estimates are made of the probable average yields of crops under irrigation in the area to be irrigated. The effects of the development of the project on incoming and outgoing freight, population, size of farms, land use, industries, farm enterprises, etc., are discussed.

The average crop yields per acre in the area to be irrigated during the 10 yr ended 1935, without irrigation, were alfalfa 1.82 tons, barley 20.84 bu, corn 17.67 bu, oats 22.9 bu, potatoes 64.8 bu, and wheat 13 bu. Under irrigation it is estimated that the yields should average at least as follows: Alfalfa 3 tons, barley 45 bu, corn 40 bu, oats 45 bu, potatoes 170 bu, sugar beets 10.2 tons, and wheat 20 bu. The estimated net increase in production due to irrigation in the area is 25,805 carloads annually. "Fattening livestock en route to market from the western range country should become a dominant farm enterprise." The development, it is expected, will also result in smaller farms, increased farm population, a large increase in incoming freight, cheap power, an increase in factories to process farm products grown, industrial expansion, need for additional labor, increase of urban population, etc.

A STUDY OF THE PATHOLOGICAL CONDITIONS IN THE EMBRYONIC DEVELOPMENT OF THE CHICKEN DURING ARTIFICIAL INCUBATION, [I]-III [trans. title] *E. E. Penjonschkewitsch.* Arch. Geflügelk., 8 (1934), nos. 6, pp. 182-197, figs. 5, Eng. abs., p. 197; 9, pp. 273-280, figs. 2, Eng. abs., p. 280; 11 (1937), no. 1-2, pp. 1-19, fig. 1, Eng. abs., pp. 17-19. These experiments were carried on in the Soviet Union. The first study presents information on various pathological symptoms in the chick embryo arising as a result of variations in temperature and humidity during the incubation period. The blood picture during embryonic development at different temperatures and humidities is indicated. It is stated that failure to maintain the optimum temperature or humidity is accompanied by specific phenomena which are characteristic of every kind of variation and specific to every case. The value of the described technic as a means of diagnosing incubation troubles is pointed out.

II. *The variation in the active reaction (pH) of the albumin and yolk of eggs, with different conditions of incubation.*—The pH curves for the albumin and yolk of four lots of eggs each subjected to a different combination of temperature and humidity during incubation are presented. The albumin reaction of all groups changed in about the same manner up to the fifth day. High temperatures tended to quicken the biochemical process in the albumin, whereas low temperatures and high moisture content each tended to retard the process beyond the fifth day. Neither high nor low temperature exerted a significant effect on the biochemical process in the yolk up to the ninth day, but beyond this point high temperatures significantly increased the rate of the process. High moisture increased the process in yolk over the high-temperature group during the first three days, and both groups rose continuously and ultimately exceeded the normal group by a considerable extent.

III. *The gas permeability of the inner shell membrane.*—This investigation, dealing with the differences in specific structure and permeability of the inner and outer shell membranes and the effects of varying temperature and humidity conditions during incubation on membrane permeability, led to the following conclusions: (1) The diminution of gas permeability of the shell membranes of infertile eggs after 5 days' incubation as compared with fresh eggs indicated that the permeability of the latter is directly correlated with the physical conditions of incubation. When humidity and temperature were maintained at 79 per cent and 38.2 C, 62.1 per cent and 38.1 C, and 62 per cent and 40 C, the average gas permeability of the membrane equaled 12 min 27 sec, 7 min 45 sec, and 7 min 9 sec, respectively; (2) the gas permeability of shell membranes may be restored under altered environmental physical conditions or by internal factors that are related to embryonic development; (3) rather large variations in the value of gas permeability were encountered; (4) in the course of incubation the moisture content of the shell membranes increases while their permeability decreases, and the drying out of the shell membranes increases their permeability; and (5) the air permeability of the shell membranes of eggs with dead germs was on the average somewhat higher than in eggs with live embryos, and approximately 6 per cent of the membranes of fresh eggs and of eggs with live embryos were impervious.

THE 14-INCH DEEP-FURROW WHEAT DRILL TESTS, *L. E. Thatcher and R. D. Lewis.* Ohio Sta. Bimo. Bul. 189 (1937), pp. 157-163. Wheat was sown, 1929-34, in a number of localities in Ohio with the 14-in disk type deep-furrow drill in comparison with the ordinary 7 or 8-in grain drill so as to provide different row spacings and rates and dates of seeding. At ordinary normal rates of from 6 to 8 pk per acre there was little evidence of superiority of the furrow drill, and there were no clear-cut instances of its lessening winter injury. Claims of savings of fertilizer have not been confirmed by critical experiments. Other objections to the deep-furrow drill are poor seed coverage of oats on disked land or very moist plowed land, the greater utility of the ordinary drill, possibility of accelerating erosion on sloping land, and the roughness of the furrowed land over which binders, mowers, and other equipment are used.

VARIATION IN SOILS WITH RESPECT TO THE DISPOSITION OF NATURAL PRECIPITATION, *R. S. Stauffer and R. S. Smith.* Jour. Amer. Soc. Agron., 29 (1937), No. 11, pp. 917-923, figs. 3. The authors of this contribution from the Illinois Experiment Station report upon the setting up of lysimeters of a type designed to permit both runoff and percolation rate determinations, since it is considered that "the infiltration capacity of soils is one of the properties about which more information is needed upon which to build erosion control practices." Some data from 18 months' operation are reported, but the paper is devoted mainly to a description of the equipment, the experimental methods, and the eight soils used.

(Continued on page 508)

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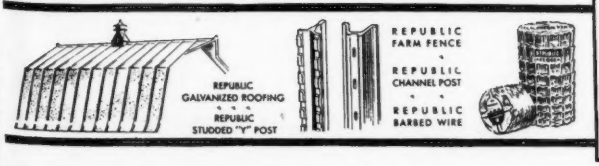

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Agricultural Engineering Digest

(Continued from page 506)

RATE OF FLOW OF CAPILLARY MOISTURE, *M. R. Lewis.* U. S. Dept. Agr., Tech. Bul. 579 (1937), pp. 30, figs. 13. In this study, cooperative with the Oregon Experiment Station, the author set up series of soil columns exposed to the evaporating influence of an air current at one end and added water at predetermined rates at the other end. When a state of steady flow was secured the soil columns were broken down and moisture content of each short transverse section was determined. That approximately steady flow had been attained was determined by weighing the tubes before and after adding water each time and plotting the rate of loss. The rate of loss became and continued approximately uniform and equal to the rate of addition, showing that dynamic equilibrium had been reached.

In general, "these data show that between approximately the field capacity and the wilting point the several soil types will transmit 1 in of water through 1 to 4 in in 8 to 20 days. From these data it is obvious that with differences in moisture content between the field capacity and the wilting point, water in sufficient quantities to support crops could be raised a few inches from a moist subsoil, but only a few inches. Examination of the curves shows that most of the movement takes place at moisture contents well above the wilting point. Losses by evaporation at the soil surface of water moved upward by capillary action are not great. The portion of the soil mass midway between absorbing roots might be well below the field capacity but still well above the wilting point before the movement of moisture through the soil would become the limiting factor in tree or fruit growth. At moisture contents below the wilting point the moisture-content gradient is extremely steep for the rates of flow used in this experiment. . . . At high relative moisture contents and with low rates of flow water may move through considerable distances. At low relative moisture contents the distance through which moisture will move is very small."

A PRELIMINARY REPORT OF AN INFILTRATION STUDY OF SOME PIEDMONT AND COASTAL PLAIN SOILS, *G. R. Free and G. W. Musgrave.* U. S. Dept. Agr., Soil Conserv. Serv., 1937, SCS-TP-13, pp. [10], pls. 5. Studies conducted by the Soil Conservation Service on the infiltration rates of Ruston sandy loam, Greenville sandy clay loam, Susquehanna clay loam, and other typical Piedmont and Coastal Plain soils are reported in a preliminary way.

The Cecil sandy loam, sandy clay loam, and clay loam represent three different degress of erosion found on the Watkinsville, Ga., site. While the Cecil sandy loam is undoubtedly eroded to some extent, it nevertheless has an A horizon 11 in thick. The Cecil sandy clay loam with a 3-in depth of A horizon represents an intermediate degree of erosion, while the Cecil clay loam has been subjected to severe erosion which has entirely removed the sandy surface cover. The total infiltration during the 3-hr period on those three soils was 1.65, 1.26, and 0.28 in, respectively. It is clear that the presence of the coarse material of the original A horizon is in this instance associated with a high rate of penetration of water into the soil.

Total infiltration during the 3-hr period on the Davidson soil was 2.47, while on the Iredell it was only 0.04 in, an amount insignificant from the viewpoint of any practical effect upon erosion control practices. Clearly, control measures on the Iredell must be designed to care for greater quantities of water than those on the Davidson soil.

The Ruston sandy loam with 8 in of A horizon, the Greenville sandy clay loam with 3 in of A horizon, and the Susquehanna clay loam with 4 in of A horizon gave infiltration which totaled 6.18, 0.60, and 0.29 in, respectively, for the 3-hr period.

Results also are reported of turbidity tests on Ruston and Davidson soils.

PLANT GROWTH UNDER CONTINUOUS ILLUMINATION FROM SODIUM VAPOR LAMPS SUPPLEMENTED BY MERCURY ARC LAMPS, *J. M. Arthur and E. K. Harvill.* Contrib. Boyce Thompson Inst., 8 (1937), No. 5, pp. 433-443, figs. 4. Continuing this series of studies, plants which grew well for a short time under continuous exposure to sodium vapor lamps degenerated slowly, only a few yellow leaves at the tip remaining after 2 mo exposure. However, such plants could be completely rejuvenated by 2 hr exposure daily to the 85-w capillary mercury vapor lamp applied along with continuous sodium vapor lamps. Excellent leaf color and flowering could be induced when plants (e. g., begonia, gardenia, cotton, geranium, buckwheat, and snapdragon) were exposed continuously to sodium vapor lamps supplemented by 2 hr daily exposure to the capillary mercury lamp. This light proved unsatisfactory for tomato.

A new set of sodium vapor and capillary mercury lamps, operated as above outlined, should burn continuously for about 7 mo. On account of the high efficiency of these light sources the cost for current at 2 cents per kilowatt is about 50 cents per 24-hr day, and one lighting unit will cover effectively at least 16 sq ft making an average cost of about 3 cents per square foot per day.

SOURCES OF MOISTURE FOR PRECIPITATION IN THE UNITED STATES, *B. Holzman.* U. S. Dept. Agr., Tech. Bul. 589 (1937), pp. 42, figs. 10. It is stated that "the supply of moisture for precipitation over the United States is derived principally from maritime air masses that obtain their moisture mainly from evaporation from oceanic provinces, only a very small part being attributable to continental evaporation. The balance of water on continental areas is maintained through the hydrologic cycle, which operates simultaneously with a cycle of air masses. Maritime air bodies invade the continents and drop a large portion of their moisture. Part [roughly, one-fourth] of this water is then returned to the oceans by runoff through rivers and underground water flow and the remainder is ultimately returned to the atmosphere by evaporation. . . . The principal amount of moisture returned to the atmosphere by continental evaporation is absorbed by continental, or dry, air masses that are generally incapable of immediately releasing their moisture and that pass off continental areas with large gains in moisture. The process of precipitating atmospheric moisture is known to depend upon several variables, and no simple procedure involving solely an increase in atmospheric moisture can be expected to increase local or other rainfall. The absolute quantity of moisture in the atmosphere has been shown to have no immediate relation to the quantity of rainfall any given climatic province may receive. Climatic regions whether arid or humid belong to their respective categories not because of the availability of moisture in the atmosphere or their nearness to a supply of moisture, but primarily because of their geographical orientation with respect to the atmospheric circulation system."

REPORT ON ACCELERATED WEATHERING TEST OF PAINTS, *L. L. Carrick.* Jour. Assoc. Off. Agr. Chem., 20 (1937), No. 3, p. 350. Contributing from the North Dakota Agricultural College, the author concludes that such weathering tests as are here considered must be adapted to local climatic conditions and specifies the cycle of exposure treatments which he has found best suited to the climate of North Dakota.

INVESTIGATIONS AT THE SOIL AND WATER CONSERVATION EXPERIMENT STATION, *G. M. Horner and S. J. Mech.* Washington Sta. Bul. 354 (1937), pp. 74-76. The progress results are briefly presented of investigations on effect of plant cover on runoff and erosion, movement and balance of soil moisture, tillage and cultivation practices for erosion control, cropping practices in relation to erosion control, terracing, and tree planting for erosion control.

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE TEXAS STATION, *H. P. Smith, D. T. Killough, D. L. Jones, J. J. Taubenhaus, G. E. Altstatt, W. H. Dameron, S. J. Mech, J. B. Pope, E. B. Deeter, P. L. Hopkins, R. E. Dickson, B. C. Langley and C. E. Fisher.* Texas Sta. Rpt., 1936, pp. 156-161, 181-186, 206-209, 233-236. The progress results are briefly presented of investigations on mechanical harvesting of cotton, factors of efficiency in the distribution and placement of cottonseed and fertilizers, treatment of cottonseed for planting purposes, planting of cottonseed at variable and uniform depths, use of rubber press wheel, width of furrow openers, atmospheric exposure of wire and fencing, garlic drying, eradication of pricklypear and mesquite brush, soil and water conservation, and soil erosion control.

CORROSION OF METALS BY MUSTS AND WINES, *E. M. Mrak, D. C. Caudron, and L. Cash.* Food Res., 2, (1937), No. 5, pp. 439-454. Tests conducted by the California Experiment Station with 46 metals and alloys are reported. The stainless steels, Inconel, and Aluminum-alloy 76 were the most resistant metals tested. Cast iron, steel, tin, Niresist, and nickel were the least resistant metals tested. The metallized metals and Durimetl were resistant, but this may have been due to tartrate deposits. Corrosion was most severe at the crushers. Metals exposed under the white crusher were usually more heavily corroded than when exposed under the red crusher. The filter charger also exerted a strong corrosive action on most metals and alloys because of agitation, aeration, and erosion. The white fermenter was more corrosive than the red fermenter. The addition of SO_2 during fermentation increased corrosion in some instances and decreased it in others. White juices or wines were usually more corrosive than the red juices or wines. Monel metal, nickel, nickel plate, silver, and silver plate corroded more at the red crusher, but these differences were not consistent in all tests.

(Continued on page 510)

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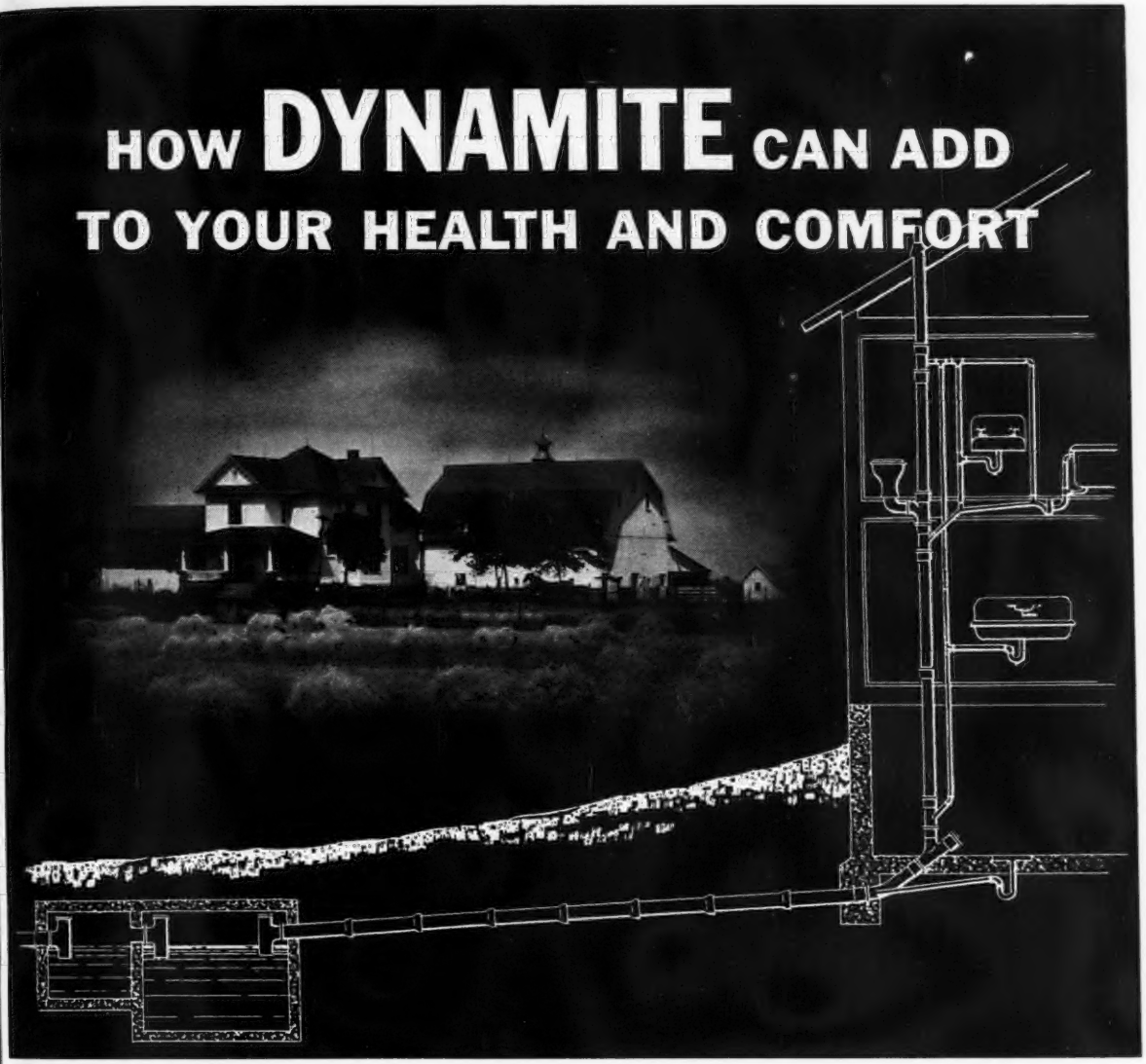

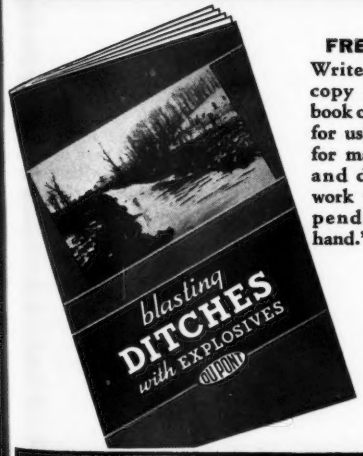

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DU PONT AGRICULTURAL EXPLOSIVES

Agricultural Engineering Digest

(Continued from page 508)

A COMPARISON OF VARIOUS TREATMENTS OF CEMENT AND STEEL WINE-TANK SURFACES, *W. V. Cruess, T. Scott, H. B. Smith, and L. M. Cash.* Food Res., 2 (1937), No. 5, pp. 385-396. Studies conducted at the California Experiment Station are reported. It was found that wines dissolved but little iron from concretes made of 22 different cements, some of which were very high in Fe_2O_3. In white dry wine, however, enough iron was dissolved in some cases probably to render the wine unstable with respect to clouding. The calcium pick-up was high with all free cement surfaces. The problem appears to be one of protection of the concrete against dissolving of calcium rather than of iron. Treatment of the concrete surface with strong tartaric acid solution greatly reduced the amount of calcium dissolved by the wine. Two treatments, one with 0.5 per cent and one with 25 per cent solution, gave better protection than one treatment with 25 per cent solution. A coating of insoluble calcium tartrate is formed. Of the commercial preparations tested in these experiments Pioneer Flintkote asphalt emulsion and Bass-Hueter black enamel gave the best results. Beer pitches and experimental mixtures of melted beeswax, paraffin, and rosin blistered badly and gave very little protection. Water-glass coatings failed to adhere satisfactorily, or did not prevent excessive reaction between the wine and concrete. Gilsonite 25 per cent plus paraffin 75 per cent gave a highly protective coating. It is inexpensive and easily applied but is somewhat more brittle than the asphalt-emulsion coating. The tests of coatings for steel were less extensive than with concrete. Of the coatings tested, a Gilsonite-paraffin mixture and Bass-Hueter black enamel gave the best results. Asphalt emulsion appears very promising, from qualitative tests not reported on in detail in this paper.

COMPARATIVE DURABILITY OF SHINGLES AND SHINGLE NAILS, *J. A. Ferguson.* Pennsylvania Sta. Bul. 353 (1938), pp. [2] + 25, figs. 13. A 25-yr test with shingles, treated and not treated with creosote, shows that the preservative treatment had a marked effect on the length of life of the shingles. Shingles of perishable woods that were given a preservative treatment with creosote were more durable than shingles of the more durable woods, not creosoted. A preservative treatment with creosote materially lengthened the life of shingles of durable woods. Through its tendency to exclude moisture, a preservative treatment with creosote betters the physical properties of wood when used as shingles; there is less warping and splitting of the shingles and less surface weathering. Shingle nails last longer with shingles that have been given a preservative treatment; this lengthens the life of a shingle roof. Shingles made from western red cedar and redwood were durable for 25 yr even when untreated, those from treated southern yellow pine were fully as durable as those from untreated western red cedar and redwood, those from Pennsylvania pitch pine were not durable even when treated, and those from Pennsylvania chestnut were durable when treated.

In the atmospheric conditions at State College, Pa., the life of blue cut and wire nails was at least equal to the life of western red cedar shingles. There was little difference in the rust resistance of blue cut nails and wire nails. Such differences as existed were probably due to differences in composition of the iron used in manufacturing the nails. Blue cut nails were slightly more rust-resistant than wire nails. The rapid rusting of shingle nails used with a western red cedar roof was caused by rain water that came in contact with the nails, due to splits or decay in overlapping shingles.

Patching wooden shingle roofs to correct splits or decay will greatly prolong their useful life. The proper placing of nails in laying a wooden shingle roof will prevent in large measure the loosening and blowing of shingles from a roof.

The results of this test apply only to regions having atmospheric conditions similar to those at State College, Pa., where the air is remarkably free from impurities.

LAMINATED RAFTERS FOR FARM BUILDINGS, *H. H. Musselman.* Michigan Sta. Quart. Bul., 20 (1938), No. 3, pp. 163-169, figs. 5. The technical details of laminated rafter roof construction are briefly described. Tests on cable reinforcing are briefly reported, indicating that on a one-sixth size model great advantage was secured from reinforcing in reduced roof distortion.

ELECTRICAL HEATING FOR HORTICULTURAL PURPOSES, *C. A. Cameron Brown.* Jour. Min. Agr. [Gt. Brit.], 44 (1937), No. 6, pp. 552-561. In a brief contribution from the Institute for Research in Agricultural Engineering of the University of Oxford, data and technical details are presented on glass house and soil heating by electricity.

1937 REPORT OF THE RURAL ELECTRIFICATION ADMINISTRATION, *J. M. Carmody.* Rural Electrif. Admin. [U. S.] Rpt., 1937, pp. VIII + 135, pls. 14, figs. 6. This report describes the activities of the Rural Electrification Administration for 1937, drawing attention particularly to the fact that rural electric service was brought to approximately 250,000 additional farm people during the year. This brought the total number of farms now having electric service up to 1,200,000 and the total number of projects now financed by the Rural Electrification Administration to 120, spread over 40 states. Eighteen states enacted new legislation to aid the initiation and operation of these projects.

SIMPLE KINETIC THEORY OF IONIC EXCHANGE.—I, IONS OF EQUAL VALENCY, *H. Jenny.* Jour. Phys. Chem., 40 (1936), No. 4, pp. 501-517, figs. 7. "A simple model of the mechanism of ionic exchange" is proposed in this contribution from the Missouri Experiment Station, and with the aid of the model an exchange adsorption isotherm has been theoretically deduced. "The equation could be verified for colloidal clay systems over a considerable range of concentration.

"Certain systems are but poorly governed by the equation. This particular behavior is explained on the basis of structural peculiarities of the colloidal particles and extreme variations of the properties of the participating ions. The third root of the base-exchange constant is shown to be equal to the ratio of the electric potentials of the double layers. This relationship directly connects ionic exchange with problems of colloid stability."

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE CORNELL STATION. [New York] Cornell Sta. Rpt., 1937, pp. 94-97. A brief historical review is presented of investigations on spraying equipment, dairy and poultry structure illumination and ventilation, farm water supply and sewage disposal, and related subjects.

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE ARKANSAS STATION, *D. G. Carter, R. M. Smith, W. C. Hulburt, and O. J. Hall.* Arkansas Sta. Rpt. 1937, pp. 10, 11. The progress results are briefly presented of investigations on the influence of poultry housing factors on egg production, farm-building design for Arkansas, water resources for rice irrigation, and use of tractor power on plantations.

FERTILIZER PLACEMENT EXPERIMENT WITH COTTON, *N. McKaig, Jr., and A. B. Bowen.* South Carolina Sta. Rpt. 1937, pp. 138-140. Progress results are reported of experiments on (1) the effects of side placement of different fertilizers by a commercial shovel-type distributor and the combination planter and disk-type distributor developed by the USDA Bureau of Agricultural Engineering, (2) side dressing vs application of all the nitrogen in the fertilizer at or previous to planting, and (3) the effects on the soil and the crop of acid-forming and neutralized fertilizers of the same plant food content.

The results indicated that the final stand of cotton plants was superior when planting was done by the Bureau machine, compared with the stand obtained where the common walking type of planter was used. Fertilizer applied under the seed or with the commercial distributor resulted in a poorer stand of cotton.

Comparisons between the yields resulting from fertilizing and planting with the Bureau machine and the commercial shovel and walking planter showed no decisive trend in favor of either method, although the latter appeared to produce a somewhat earlier crop. Application of the fertilizer in a band under the seed at planting time resulted in a very poor yield, due to lack of stand, as the germination following this treatment was very unsatisfactory. The effects were not so serious when the fertilizer was mixed with the soil under the seed 10 days prior to planting, although the yield from this treatment was inferior. Treatment which consisted of applying the fertilizer in a shallow mark in the soil and bedding produced a very late crop.

IRRIGATION DEVELOPMENT IN MONTANA.—PART 1, WATER SUPPLY, *O. W. Monson, C. McKee, and P. L. Slagsvold.* Montana Sta. Bul. 353 (1938), pp. 55 + [1], figs. 11. In this bulletin an attempt is made to give a picture of Montana's water supply from rivers and small streams. A brief description is given of the present and potential uses of this water supply, together with a discussion of some of the problems involved in its development and use, primarily from the standpoint of irrigation.

WATER AND SEWAGE RESEARCH BY THE NEW JERSEY STATIONS. New Jersey Stas. Rpt. 1937, pp. 113-116. Progress results are briefly reported of investigations on activated sludge, chemical coagulation, garbage in sewage, pathogenic organisms in sewage and activated sludge, treatment of industrial water, and effect of trade waste on sludge digestion. *(Continued on page 512)*

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REPORT OF THE CHIEF OF THE BUREAU OF PUBLIC ROADS, 1937, *T. H. MacDonald.* U. S. Dept. Agr., Bur. Public Roads Rpt., 1937, pp. 73. This report describes the activities of the Bureau during 1937, with particular reference to Federal-aid road construction, maintenance, and improvement. Among other features, special reference is made to the physical research program of the Bureau which, during the year, dealt with subsurface exploration; motor vehicle impact investigations; measurement of road surface roughness; investigation of concrete pavement design; investigation of corrugated metal culverts; flexible pavement design; investigation of supporting strength of flexible culvert pipe in earth embankments; investigation of bridge floors; portland cements, aggregates, and concrete; bituminous road materials; and subgrade investigations.

WHAT IS SOIL EROSION? *C. F. S. Sharpe.* U. S. Dept. Agr., Misc. Pub. 286, pp. [4] + 84, figs. 101. Soil erosion is described from the geological viewpoint as an accelerated phase of natural erosion.

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE NEW JERSEY STATIONS. New Jersey Stas. Rpt. 1937, pp. 28, 29. The progress results are briefly reported of investigations on poultry housing, sweet potato storage, and farmhouse and farm building planning.

NEBRASKA TRACTOR TESTS, 1920-1937. Nebraska Sta. Bul. 313 (1938), pp. 43. This bulletin reports the results of 93 tests of tractors conducted during the 18 yr of tractor testing at the station and includes data on all tractors reported by their manufacturers as on the market January 1, 1938.

BIBLIOGRAPHY ON HIGHWAY SAFETY, COMPILED BY *M. A. Wilson.* U. S. Dept. Agr., Misc. Pub. 296 (1938), pp. [1] + 136. This bibliography is selective in character and includes references to books, articles printed in technical and other periodicals, and publications of societies. It covers the period from 1928 through May 1937.

RESEARCH IN AIR CONDITIONING FOR THE MILLING INDUSTRY DONE AT KANSAS STATE COLLEGE, *C. O. Swanson.* Northwest. Miller, 193 (1938), No. 1, pp. 44, 46, 49, 51, 52. The experiments in air conditioning at the Kansas Experiment Station conducted as a supplement to the work in wheat tempering are described.

THE UTILIZATION OF BAMBOO IN THE CONSTRUCTION OF EQUIPMENT FOR FARM HOMES AND DWELLINGS [TRANS. TITLE], *A. Lee.* Rev. Agr. Puerto Rico, 28 (1937), No. 4, pp. 640-646, figs. 3. In a brief contribution from the Puerto Rico Federal Experiment Station experimental work on the use of bamboo for the construction of essential household articles and equipment is described.

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Literature Received

"MECHANICAL TRAINING," by William Boss, J. Grant Dent, and Hall B. White. Second edition, xi + 273 pages, 6x9 in, illustrated. An elementary text of instruction on the use of mechanical tools, with exercises for demonstrating fundamental principles in mechanical work, also a reference for the practical mechanic, brought up to date as to materials and methods developed since publication of the first edition in 1931. The subject matter, as divided by chapters, includes equipment, tool sharpening, soldering, cement work, rope work; belts, pulleys, and laces; electric wiring, leather work, pipe fitting, cold metal work, babbitting, forge work, auto and tractor engine jobs, woodworking; and painting, wood finishing, and glazing. Indexed. Bruce Publishing Co. $3.00.

"IRRIGATION — A SELECTED BIBLIOGRAPHY," compiled by Dorothy W. Graf. Mimeographed, 631 pages, 8x10½ in. Publications on the subject are listed and briefly described in references classified according to the phases of the subject covered, including groupings of general articles, bibliographies, specific crops, equipment and construction, irrigated lands, methods, geographic area interests, and many other aspects of the subject. Indexed by authors. Bureau of Agricultural Engineering, U. S. Department of Agriculture. Listed as publication No. 6017. No price stated.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

JUNIOR AGRICULTURAL ENGINEER. The U. S. Civil Service Commission announces an assembled open competitive examination for junior engineers, including agricultural engineering as one optional branch. Applications must be on file with the commission at Washington, D. C., not later than November 14, or for those mailed from any of several named states in the far West, November 17. Application form 8, copies of which may be obtained at any first-class post office, should be used in filing application for this examination. In the examination 50 per cent of the weight will be placed on engineering fundamentals and 50 per cent on the optional subject chosen. Applicants must have successfully completed a full 4-year course leading to a bachelor's degree in engineering, in a college or university of recognized standing. Other usual Civil Service examination regulations apply. More detailed information is given in the Commissions announcement No. 101, dated October 24, 1938.

POSITIONS WANTED

AGRICULTURAL ENGINEER with a farm background desires employment in the field of irrigation or farm machinery. Educational or demonstrational work preferred. Holds a degree in agricultural engineering. Has one year's experience in highway engineering and four year's experience as a CCC camp engineer for the Soil Conservation Service in the Middle West and Central Atlantic sections. Has had considerable experience in contacting and working with farmers. Employed. Age 29. Married. PW-295

AGRICULTURAL ENGINEER, B. Sc., 1934, Oregon State College. Farm reared, four years experience as engineer with Soil Conservation Service. Desires connection in college or industrial extension, farm machinery or farm management. Single. Age 27 years. PW-296